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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE NATIONAL IRONFOUNDING EMPLOYERS' FEDERATION, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Registered Office and Laboratories of the B.C.I.R.A. at:—
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Telephone: Central 1885. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone* 332).

Forthcoming Events.

DECEMBER 8.

Institute of Metals (Sheffield Local Section):—Meeting, at 7.30 p.m. "Modern Application of Electric Heat," Paper by J. C. Howard.

DECEMBER 12.

Institution of Welding Engineers (North-Western Branch):—Meeting at Liverpool School of Technology, at 7.15 p.m. "Welding as applied to Ship Construction and Repair," Paper by S. E. Evans.

Institute of British Foundrymen.

DECEMBER 7.

London Branch:—Meeting, at 7.30 p.m., at rooms of the Society of Motor Manufacturers and Traders, 83, Pall Mall, S.W. Joint meeting with the Institute of Metals.

DECEMBER 8.

Middlesbrough Branch:—Meeting at Technical Institute, at 7.45 p.m. "Heat-Resisting Cast Iron," Paper by E. Morgan.

DECEMBER 9.

East Midlands Branch:—Meeting at College of Technology, Leicester, at 6 p.m. "Welding of Cast Iron and Aluminium," Paper by H. P. Smith.
East Midlands Branch (Lincolnshire Section):—Meeting, at 7 p.m. "Experiments on the Solidification of Alloys," Paper by T. E. Hartley (with practical demonstration).
Scottish Branch:—Meeting in Glasgow, at 4 p.m. "Refractories in the Foundry," Paper by F. S. Russell. Evening—Annual Dinner.
West Riding of Yorkshire Branch:—Meeting at Bradford, at 6.30 p.m. "The Progress of Machine-Moulding Practice," Paper by F. E. Steele.

DECEMBER 12.

Lancashire Branch:—Meeting at Manchester, at 4 p.m. "Unorthodox Methods of Commercial Moulding Sand Control for the Modern Ironfounder," Paper by F. Hudson.

In the News.

There has been a revival of interest in the question of cupola conduct, and discussions have recently taken place before the London Branch of the Institute of British Foundrymen, the Ceramic Society and the Sheffield Trades Society. We are satisfied that the newer methods, such as the Balanced Blast and Poumay cupolas, give all the fuel economy one could wish for. But fuel economy is not everything. Coke is used in bulk, and adequate provision in modern foundries is made for its economic handling. The refractory problem is, however, much more different. A relining means a shut down for several days, followed by a worrying time as to how the furnace will function on restarting. The daily patching is a one- or two-man job carried out with a minimum of supervision by the executives, who place a maximum amount of confidence in their men chosen to carry out the work. The actual cost of material may be but a quarter or third of that of the coke, but unlike coke it requires much handling of the expensive "messing about" type, and often a special technique for application which makes its true cost much higher than a first examination would disclose.

Comparisons with blast-furnace practice are unfair, as there is the intermittent heating up and cooling in cupola practice and a more rapid movement of the charge, which increases abrasion on the bricks. Comparisons of the performances of one cupola with another are equally unfair unless all conditions are known, as length of runs, type of scrap used and temperature obtained are too variable to admit of correlation. We expect that the general outcome of the various discussions will be a recommendation to experiment in the direction of high alumina materials.

The British Refractories Association have issued, through us, an invitation to co-operate in a piece of research work. For this we express our thanks, but suggest co-operation with the Institute of British Foundrymen's appropriate Committee and the British Cast Iron Research Association, who have between them all the facilities for testing any theoretical notions which arise from the accumulated experience of the experts in refractory materials.

Fuel and Man.

Sir William Larke delivered an interesting Presidential address to the Institute of Fuel, and defined fuel as "any substance the combustion of which produces heat." He refers to the decline of iron smelting in the south of England as a consequence of the embargo on wood as fuel, the number of furnaces declining from three hundred in 1665 to fifty-nine in 1740. It was in 1735 that Abraham Darby produced pig and cast iron by the use of mineral coal first converted to coke by open burning. It is considered that the steam engine not only helped Darby to increase the blast through his furnace, but by the application of mechanical power increased the demand for the iron, which Darby was able to make more quickly and more cheaply. The two inventions combined ushered in the era in which we now live.

Sir William stresses the fact that although the properties of steam were in some measure known before the dawn of Christianity, it was not until the middle of the 18th century that they were applied to industry. The industrial revolution did not spread to the United States until 1830, and to Germany until 1848. Since then the progress has been colossal. The consumption of coal per head in Britain has risen from one-third of a ton in 1660 on a population slightly over six millions to 2¾ tons per head in 1851 with a population of about twenty millions. Subsequent comparisons in the Paper include other countries, since following 1830 the use of fuel for power proceeded not only in Great Britain, but in America, Germany, and France.

We have heard a great deal in recent years about the use of water power and oil as rivals to coal. Figures are disclosed in the Paper to show that of the world power production in 1932 water was responsible only for 3 per cent. of the total, and oil for 19 per cent., leaving 78 per cent. to be furnished by coal and lignite.

Reference is made to the possibilities of hydrogenation of coal, the use of pulverised coal, and the use of compressed gas. Sir William points out that there is no known method of concentrating or converting the radiant energy of the sun into a controllable mechanical force, and we have Lord Rutherford's recent pronouncement that the idea of obtaining energy from the dissociation of the atom is moonshine. It is, therefore, obvious that the foundryman need not look beyond coal as the fuel, or the source of the fuel, which he must use in melting furnaces, either as raw coal—nowadays in a pulverised form—as metallurgical coke, or as oil.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Technical Control of Small Foundries.

To the Editor of The Foundry Trade Journal.

Sir,—I thank Chem-Met for his letter in your issue of November 23, and for the opportunity he gives me of correcting a misapprehension, probably arising from the necessarily condensed report of my lecture at Derby in your issue of November 16. I most emphatically do not discourage the selection of chemists for technical control posts. On the contrary, chemical training would probably be very suitable, as indeed it has proved in a number of cases, for a man desiring to take up such work. My point was this: If a small foundry wishes to instal some form of technical control, I think it is preferable to employ a suitably trained young man in the foundry itself (which, after all, is where the control must be exercised) rather than to confine him to the laboratory. At the same time I think that the label he is given (chemist, metallurgist or technical assistant, etc.) is of less importance than the function he performs, just as I think the course of training itself is less important than the man who undertakes it. Reference to the second paragraph of your report will show that I had the same man in mind.

Respecting the B.C.I.R.A. report on Recommended Methods of Analysis, heterogeneity in castings likely to lead to differences in analysis can be overcome in cases of dispute by both chemists working on a joint sample, and in such cases the above publication recommends that the method of sampling should be agreed upon and a joint sample taken.—Yours, etc.,

J. G. Pearce
(Director, The British Cast Iron Research Association).

21-23, St. Paul's Square, Birmingham, 3.
November 25, 1933.

Book Review.

Steel Makers. By Harry Brearley. Published by Longmans Green & Company, Limited, 39, Paternoster Row, London, E.C.4. Price 5s. net.

This is not a technical book, but a book about technicians and others with whom they rub shoulders. Moreover, they are individuals treated in a Shavian way, that is, they are handed a few bouquets and then receive a "kick in the pants." The author has several axes to grind, which probably helps to give the book the kick it undoubtedly possesses, but, in addition, he has a great message to deliver and that is, the "art" side of industry is as important as the "science." The "axes" refer to the treatment meted out to inventors of metallurgical processes by industrialists and the reservation of "cushy" jobs for university graduates.

The divisions of the book are interesting and ingenious, and are worth recital:—The Furnace, Raw Materials, Pot Making, Cellar-Lads, Odd Men, Pullers-out, Bosses, Chemists and Metallographers, Products and Industrial Education. The "order of batting" is distinctly interesting, as they represent progressive steps, with the "chemist" as a sort of outsider. Curiously enough, that is his job! He should be a liaison officer between the skilled men and the "bosses." In this book we are given some details of Mr. Harry Brearley's early history. To imagine this great metallurgist—the inventor of stainless steel—following coal carts and inducing tempting morsels of coke to fall away by the process of "tickling" is almost unbelievable to those who, like the reviewer, has the privilege of knowing him personally and appreciating his undoubted scientific attainments. His early career as an experimentalist, both when at school and as a cellar-lad, which is so interestingly recounted in the book, gives the key to the author's character and views. No doubt it is responsible for such a statement as, "It would be foolish to deny the fruitfulness of the enormous labour, patient and often unrewarded, which has replaced the old cookery-book method of producing alloyed metals by an understanding intelligence which can be called scientific. But it would be hardly less foolish to imagine, because a subject can be talked about more intelligibly, that the words invariably will be "words of wisdom," or, again, "There are complaints that what should be, or might be, a clearing house for difficulties is apt to degenerate into a prestcraft able to obscure a difficulty if not to explain it."

The chapter which is most provocative of all is that dealing with "Industrial Education." The author's views are definitely constructive and intelligent. He proposes that qualification for leadership in industry should be knowledge of how to do the job. This brings in a discussion of the university graduate, and an appeal is made to his sportsmanship and team spirit to give the man on the floor a decent chance to compete with him for the big jobs, because if a university training is worth anything at all, he starts with real advantages, and, therefore, there should be no need to create closed corporations reserving the big jobs for degreed men.

We sometimes wish the author had been a foundryman instead of a specialist in steel, as his type of brain would have done much to advance the industry in all its phases, and we very strongly recommend all our readers, owners, managers, foremen and metallurgists to buy this book, for we can guarantee that they will get a new angle on their own particular job.

V. C. F.

Next Meeting of the London Branch.

The next meeting of the London Branch of the Institute of British Foundrymen will take place at 7.30 p.m. on December 7, 1933 (not December 6, as in the programme), at the rooms of the Society of Motor Manufacturers and Traders, 83, Pall Mall, S.W. On this occasion members of the Institute will be the guests of the Institute of Metals, and Mr. J. R. Handforth, M.Sc., of Messrs. D. Napier & Son, Limited, will deliver an address entitled: "A Metallurgist's Outlook on Modern Foundry Production."

(Concluded from next column.)

Of course we 'ad to try again and we struck it lucky at fourth time. You can't believe t'state we were all in by this time. When we poured that last mould we sweat like bulls, and it weren't heat o't' metal 'at did it either! I saw that casting cool every degree 'an I fettled it myself, and at eight o'clock that night I put it under t'bench in my office and locked t'door. I were taking no chances I'll tell you! I took that ball to t'test next day missen and saw it stand 400 lbs. and not a leak, not a drop!"

For a moment his voice became triumphant and his eyes shone with the pride of achievement, only to become like two pools of misery as he resumed his story. Speaking slowly and deliberately, he demanded, "And then do you know what they did?" His voice rose to a screech of indignation as he answered his own question. "They bored six hundred and forty two holes in it for a'injector globe!"

And when I could make myself heard, I could only mutter feebly to an astonished barmaid: "Same again, Miss, quick—only double."

Marksman.

Random Shots.

I cannot tell you this story as it was told to me. I can describe the scene of its telling—a long, low room brightly lit, a somewhat faded green carpet covering the whole of the floor and matching heavy curtains tightly drawn over large windows, shutting out the heavy fog which a dreary fire was doing its best to dispel. The real fog dispeller (and heat source, come to that) was being dispensed, however, by a lady, the only one present, in various types of glasses. The fog must have been bad, judging by the speed with which that lady was kept at work! We sat, the story teller and I, in green plush seats gloomily and mournfully, for it was a mournful story which even the spirit of Caledonia's brightest glen could not relieve. I can describe the scene; but no pen could portray the depth of pathetic sadness, or the intensity of the expletives, with which the story was told.

* * *

He began again to tell the story, and as I saw that its telling somewhat assuaged his tragic grief, I bent my ear for the fifth, or was it the sixth, time! "Did I ever tell you about the ball I made at—no? Well! listen!" He fortified himself—from my glass I noticed only too late—and continued: "We got some queer jobs. Many a time I've had patterns sent to me 'at nobody else would a' looked at, and I reckon I made a job on 'em. Some took some doing, I'll tell you! We didn't get a good casting every time, nor first time either. I 'ave 'eard some chaps talk about 2 per cent. o' scrap, and last week one o' these motor cylinder fellers told me they'd point some 'at per cent. in their foundry, but we were moulders making 'owt 'at came. We weren't nurses for a lot o' conveyors, staring at one casting all t'day." He paused vehemently and looked around the floor for the nearest cuspidor, and not finding it, vented his contempt for mechanisation by another gulp of the lubricant—but out of his own glass this time, as I was holding my own for safety. "Well!" he resumed, "one day they brought me a pattern of a ball about six inches across, and the order said it were to be in Admiralty metal. 'Appen you think there's nowt in that!" mistaking the replacing of my glass for a deprecating wave of the hand—"well, try it and see! If you can make a good ball first time off you're halfway to being a magician and all t'way to being a good moulder. Well! anyway, we couldn't. We made six bad 'uns. Some on 'em were bad and some on 'em were worse. I cursed a bit, naturally, but t'moulder 'at I gave job to 'ad cursed up before week were out. Next week 'e 'ad another go, and by Tuesday night he got a good 'un. We were all very pleased, and all chaps 'ad a good look at it, and that moulder 'at made it felt as pleased as if 'e'd been a 'en and laid it. I told foreman fettler to be as careful with it as if it were an egg, and, by gosh! he were. They took t'runner off with a hacksaw!

* * *

Did I tell you it were a 'ollow ball? Oh, well! I *thought* you didn't seem to understand. Well it were 'ollow, all right, and a quarter thick, and an inch hole to get t'core out. Well! I sat back and waited for t'raise in my wages, when that casting went down into t'shop. But I didn't get t'raise—I got t'ball back. They'd put t'damned thing on't watter test and they said it leaked round where runner 'ad been. Porous they said."

He stopped to quench his thirst and took the opportunity to laugh sardonically into his almost empty glass. I also drank—deeply.

Somewhat recovered he returned to the ball. "I used to watch United, rain, hail or snow, but I've never seen a football since that day without wanting to kick it to —— yes, all right! same again, Miss.

(Concluded in previous column.)

The New Mechanised Foundry of the Sinclair Iron Company, Limited.

By Vincent C. Faulkner.

When the Americans toured Great Britain in 1929 there was scarcely a mechanised foundry to show to them. To-day, there must be something of the order of 30. The continuous-casting plant at the Sinclair Iron Foundry, of Wellington, Shropshire, is amongst the latest to be put into commission, and at the time of our visit it had reached the stage of working the plant on day-rate wages, prior to turning over to piece rates.

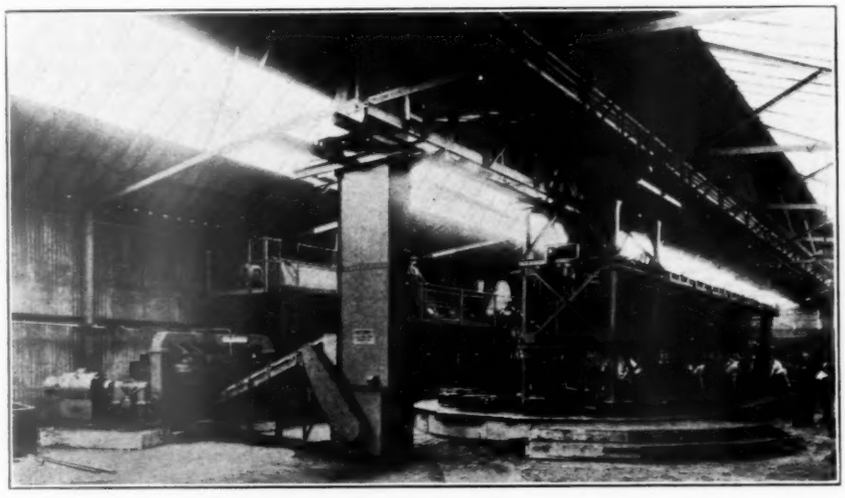

Fig. 1.—The Mechanised Moulding Plant, showing the Sand-Preparing Plant and Elevator at the Works of the Sinclair Iron Company, Limited, of Ketley, Wellington, Shropshire.

The plant occupies an area of about 100 ft. by 40 ft., and consists essentially of seven moulding machines housed within a round-cornered, rectangular, complete table top mould conveyor surmounted by hoppers, giving a continuous supply of sand, and a sand-preparing plant; but the functioning of the plant demands ten belts and two elevators. In parentheses it may be stated that we have noticed a general tendency in continuous-casting plants to limit the number of elevators and increase the number of belt conveyors.

Moulding Machines.

At the time of our visit the plant was mainly engaged upon air bricks, but it is designed to take care of a large number of types of builders' castings, excepting gutters and fall pipes. The machines which have been placed in commission are four Nicholls jar-ram squeezers, two Osborn jar-ram turnovers and a Berkshire. After the moulds are made they are placed on a mould conveyor, as is shown in our illustration, Fig. 1. This conveyor is formed of a number of interlocking wheeled bogies running on rails and carrying cast-iron plates, the whole being chain driven by a 3-h.p. motor, capable of giving a wide range of speeds. Its general construction will be better appreciated by an examination of Fig. 2, which shows the knock-out end of the plant.

Sand Preparation and Cleaning.

There are two patented knock-outs, one of which is shown in Fig. 2, whilst the second is similarly located a little further in the background. The knock-out consists of a grating raised and lowered by the operation of an eccentric; the jar thus communicated effectually rids the boxes of their sand and castings. The boxes are put back on the mould conveyor and returned to the moulders, whilst the castings are taken away to be fettled. The sand drops through the grating, and, owing to the nature of the work and control of conditions, there is no dust problem. Beneath the grating is a hopper, which deflects the sand on to a 2-ft. wide belt, which takes care of both knock-outs. Near its discharge, it receives the feed from the "new-sand" belt conveyor. New sand and coal dust in predetermined proportions are introduced through a grating about 15 ft. from the nearer knock-out, and fall on to this conveyor. The combined stream of old and new sand is received by a long inclined conveyor about 70 ft. long. This helps in some measure to cool it, but this is really tackled by the next section, upon which the inclined conveyor discharges. The pulley over which the long conveyor runs is a magnetic one, and here the tramp iron is eliminated and drops into a wheel-barrow. The tramp-iron free sand is fed on to an 18-in. wide belt running over a sand-storage hopper of 14 tons capacity. This belt is fitted with six ploughs staggered along its length, and each pair is a little longer than the preceding pair, so that the final ones stretch halfway across the belt. The base of the storage hopper is formed by a 30-in. wide belt running between 15-ft. 6-in. centres. This feeds the sand into the boot of a 10-in. bucket elevator discharging direct into a horizontal tapered rotary screen. The riddled sand falls several feet on to a 20-in. belt, feeding a 15-ton-per-hour continuously-operating sand mill of the Baillot type, of which a detailed description was given in an article* dealing with the mechanised continuous moulding plant installed in the works of Messrs. Ferranti.

A 12-in. belt running at right angles to the general sequence of operations previously described takes the sand to the boot of an elevator, shown clearly in the foreground of Fig. 1. This 10-in. bucket elevator raises the sand to discharge it on to an 18-in. conveyor, which feeds the sand into a jolt-type disintegrator of the type which throws the sand through a series of suspended prongs, the jolting serving to prevent the sand sticking. From the disintegrator the sand falls on to an 18-in. wide distributing belt conveyor, stretched over 66-ft. 6-in. centres. At the end of this conveyor (shown in Fig. 2) there is an overflow shute which feeds on to the surplus-sand belt conveyor which runs under the floor beneath the line of the moulding machines, so that the working places are kept free from accumulations of sand, and there is no need for the moulders to be parsimonious in its use. It will be seen from the above general description that the sand movements have in every case taken into consideration the cooling of the sand, as this helps to keep the dust problem within reasonable bounds, and it can be stated that we have never encountered a more dust-free mechanised plant than the one at Ketley. The ploughing-off of the sand over the storage bin, the enclosing of elevators to give a chimney effect and several other features all betoken an intelligent appreciation of this problem.

It may be interesting to note that the order for starting up this plant is virtually in the reverse order to the description. The whole plant is push-button controlled from a conveniently-placed switchboard, supplemented by several auxiliary push buttons disposed about the plant, which can shut down every motor simultaneously. A plant of this character will carry about 13 motors, totalling up to about 75 h.p.

The metal is melted in an adjoining shop and methods of its mechanical conveyance are under

(*Concluded on page* 306.)

Fig. 2.—The Knock-out End of the Mechanised Moulding Plant at the Works of the Sinclair Iron Company, Limited.

* Foundry Trade Journal, August 4, 1932, page 65.

The Search for New Markets.

PRESIDENTIAL ADDRESS TO LANCASHIRE BRANCH.

The opening meeting of the Lancashire Branch of the Institute of British Foundrymen for the Session 1933-34 was held at the Engineers' Club, Albert Square, Manchester, on October 7. Mr. Arthur Phillips presided, and there were also present Mr. J. Taylor, President of the Burnley Section, Mr. W. West, President of the Preston Section, and Mr. R. A. Jones, President of the Junior Section.

PRESIDENTIAL ADDRESS.

Mr. Arthur Phillips, in the course of his address, said that the Branch Council had decided to accept the offer to hold ordinary meetings during the present session in the Engineers' Club. As a result of that decision it was his privilege to welcome members there this afternoon. Through the courtesy of the Club Committee members attending Branch meetings were entitled to all privileges of membership for the day of the meeting after 4 p.m.

This building, which was well equipped both for their meetings and social activities, was also the home of the Manchester Association of Engineers and the Manchester Metallurgical Society, two Societies with which it was hoped to become more closely associated now that all meetings were under the same roof.

It was not proposed to give a lengthy address, but there were, however, two points to which he wished to draw attention:—(1) What the country owed to castings; and (2) what were the future markets for castings. Civilisation had made greater strides during the past fifty years than in any similar length of time in all the history of mankind.

Progress shown in every human activity had eased the burden of men and women, and had also raised the standard of living. One could hardly visualise the full range of human achievements in the last fifty years, but a few outstanding innovations which have helped to improve the amenities of daily life include wireless, aviation, improved transport methods, labour-saving household devices, etc.

This period has also proved the greatest development in the application of castings to the service of humanity, and men and women everywhere who find themselves surrounded by the products of science and invention in their leisure and recreational hours, failed to realise that the products of the foundry industry have made these things possible. Everywhere there was evidence of the remarkable progress which has been made in the application of castings as engineering materials, but very few were conversant with the societies and agencies that have worked unceasingly during the last thirty years to place castings in the position where they can be accepted to meet the improved standard of modern engineering practice.

One of these instruments was the Institute of British Foundrymen, which, with its accumulated experience and knowledge of foundry practice which was distributed throughout the country by means of technical and practical Papers during the year, together with other activities such as the Technical Committee, covered important problems and the most recent developments in the fields of cast-iron founding, non-ferrous metals, malleable iron and steel practice. When it was considered that the Lancashire Branch was part of the Institute of British Foundrymen, which had assisted in this half-century of mechanical and electrical progress, the Branch could be congratulated on being of some service to civilisation. The Institute held great traditions of service to the foundry industry in the past, and it hoped to maintain this tradition in the future, but probably one of the greatest problems for future solution would be to secure and extend markets for castings.

It was well at times to detach oneself from the immediate matters which were one's everyday concern, such as improvement in foundry technique, the method and production of new alloys, the education of foundry apprentices, etc., and from a distance try to obtain a general idea of our future markets.

The future is likely to see a keener rivalry for markets abroad. The competition of the European nations and the United States, together with the difficulties of unstabilised rates of exchange, would make foreign markets difficult to obtain, and overseas customers too uncertain to rely upon as an outlet for goods. This also included the castings the foundryman produced.

An examination of past and present markets would probably supply some slight idea of the changes which had taken place in the use of castings.

It was to Abraham Darby, the first of a succession of ironmasters bearing the same name, that the credit of first adopting the smelting of iron by means of coke and coal, on a large scale as the regular method of manufacture, belonged, and in 1709 he commenced work at Coalbrookdale, where he won world-wide fame for his casting not only of pots, kettles and other hollow-ware direct from the furnace, but for grates, smoothing irons, door frames, baking plates, cart brushes, iron pestles and mortars, and other products. In the year 1779 the third Abraham Darby, with John Wilkinson and others, made and erected a cast-iron bridge to span the Severn, which is known as the "Iron Bridge." This bridge has a span of 100 ft. 6 in., and the total weight is 378 tons 10 cwts. When one considered that the main ribs of the bridge, which were cast in pieces 70 ft. long, with sections 9 ft. 7 in., each weighing nearly 6 tons, were elevated by ropes on a scaffold, and then lowered until they met in the centre, 40 ft. above the river, together with the method of iron wedges to hold the different parts, one could obtain some idea of the great changes which have taken place from the time this gigantic eighteenth-century structure was erected to the mammoth non-cast bridges of our own days. This reference to the Cast-Iron Bridge has been made, not as a lost market to the foundry industry, but to show what position cast iron held in those days.

During the period of 154 years since the Iron Bridge was made, the manufacture of ferrous and non-ferrous castings has passed through a number of changes. A hundred years ago castings were accepted simply as castings. Approximately 50 years ago commercial tests of the materials used in the manufacture of castings were instituted. To-day the foundryman must produce castings to conform to high-test specifications, with both physical and chemical properties, to be adhered to and under the rigid inspection of inspecting engineers for conformity to sections, etc.

This has, during the last 20 years, supplied the engineer with information about the disadvantages common to some cast metals and tends to restrict their use. Whether they can be given wider application in the future would depend upon the founder's ability to improve these metals, and on the development of other alloys to take their place for the making of castings.

Everyone was conversant with the type of large castings that were required up to a few years ago, and which found employment for a large number of foundrymen. But to-day the change in the type of plant that supplies power for mills, etc., has resulted in the abandonment of this heavy type of castings, and, consequently, the number of foundries supplying castings has been reduced.

A keen spirit of inquiry amongst foundrymen, together with the use of new alloys, had, however, resulted in castings being employed in a number of instances where a few years ago their use would not be considered possible. Examples of this are evident in the use of cast iron for roadways, all-metal omnibuses, air liners, the last of which now utilised 183 castings in its construction.

With all the modern uses of castings, there was a large number of foundries which needed orders for castings, and with the movement towards higher standards of design, coupled with the search for economical production of apparatus, one must be constantly examining the future position.

Considerable interest has recently been aroused in the use of plastics and fibrous products, which were competing with certain metal products. There was also the probability that in the near future a new pipe material may offer keen competition to the metal pipes. These, together with the elimination of certain castings in fabrication and the shrinkage of foreign markets, would make it necessary to open up new avenues for castings in the future.

The President suggested that both the Lancashire Branch and the Institute as a whole should become interested in future markets for both ferrous and non-ferrous castings, and might even inaugurate a scheme with the object of finding and rewarding those suggestions which promise further developments in the use of castings.

There were schemes for rewarding the best contributions to the Branches and to the Institute for improvements in foundry practice, etc., but no doubt a large number would agree that a very useful contribution to policy and practice in the foundry industry would be "What can be made in castings, and to what new uses may castings be put?"

With the birth of the aluminium age there appeared a new outlet for castings in certain directions, and one was frequently astonished at the announcement of some simple improvement, due to the inclusion of a casting, that the step was not taken before.

If such a scheme as was suggested could be organised, and the best contributions of that scheme be circulated to subscribing firms, it would advance the interests of the Institute. The result would be to find work for the industry, and that was what was required.

Mr. W. N. Cook (Stockport) proposed that a very hearty vote of thanks be accorded to the President for his extremely interesting address.

Mr. J. Jackson (Accrington) seconded the vote of thanks, and it was carried unanimously by acclamation.

The New Mechanised Foundry of the Sinclair Iron Company, Limited.

(*Concluded from page* 305.)

consideration, as is also the question of dealing with the castings at the knock-out position.

The design and construction of the plant has been carried out by Foundry Equipment, Limited, of 19, Victoria Street, London, S.W.1.

In conclusion, we wish to express our indebtedness to Mr. W. H. Watkins and Mr. J. Pickin, respectively managing director and foundry manager of the Sinclair Iron Company, for their kind collaboration in the preparation of this article.

Titanium in Stainless Steel. — Technical Publication No. 506 of the American Institute of Mining and Metallurgical Engineers deals with investigation into the introduction of titanium and columbium into straight chromium stainless steels. The authors (F. M. Becket and R. Franks) conclude that the introduction of these elements in varying amounts widens the field of application for chromium rustless steels.

Grey-Iron Castings for Laundry Machinery.

By J. Longden.

(*Concluded from page* 296.)

Pneumatic Press Castings.

In Fig. 13 is shown a Tullis pneumatic press. The chief material in its construction is cast iron. The machine consists of the sand, carrying the air cylinder, fulcrum arm, levers and the upper and lower "bucks." Space will permit here only to draw attention to the making of the "bucks." Fig. 14 shows a selection of a few types of these, which are of many shapes and sizes. Each of these castings is a steam-heated jacket, one face of which is machined and highly polished, and which is afterwards coated with electrolytically-deposited nickel. Each is tested by water at 240 lbs. per sq. in. and at 150 lbs. steam. The metal thickness is $\frac{3}{8}$ in. A plan and section of a "buck" is shown in Fig. 15. It will be seen that the two outer walls of the casting are joined up by 48 webs. The core for this type of casting is exceedingly delicate in its construction. The core is a plate of sand $1\frac{1}{4}$ in. thickness and 15 in. by 3 ft. 9 in. through which the 48 webs shown penetrate. This is completely enclosed in metal, except at the external holes.

A view of the mould and core is shown in Fig. 16. The moulds are made in dry sand. The core construction is on the same principle as in the case of the ironer beds. For the "buck" in the sketch, three thin cast-iron core-irons are tied to four tubes, which are kept at sufficient length to protrude at each end of the moulding box when closed. The tubes are $\frac{3}{8}$ in. inside diameter and $\frac{5}{8}$ in. outside. They are drilled for venting every 3-in. interval along their length. These, with a few loose wires, give sufficient stability to the core, which is made in oil sand. The tubes also, with a few wax vents, adequately vent it.

A job of this character presents some difficulties. It is necessary, in order to get a spotless working face, to hang the core in the top part, as seen in Fig. 16. This is reduced to simplicity by means of end plates, which are provided with holes of slightly larger diameter than the core tubes. After the core is placed in the mould the plates are slipped over the tubes at the end of the box. One $\frac{3}{8}$-in. bolt then screws the plate to the end of the box and the core is firmly held.

In this job, success depends mainly upon free venting of the core. A well-baked core and mould are imperative. They are cast with metal at a temperature of about 1,320 deg. C. and, like the ironer beds, are cast "on the bank." There is no doubt that, in cases like this, casting on the slant is advantageous. When such a mould is cast on the flat, the metal fills the mould up to the top of the core, and then covers up the top of it in a flood, when a certain amount of bubbling will take place until such time as the head of metal is sufficient to face the newly-generated gases through the vents provided for them. In a thin casting particularly, and one which is intended to stand up to steam pressure, bubbling in any degree is dangerous. On the other hand, a mould cast at an angle to the horizontal fills up gradually, from the lowest part first, creeping up under and over the core. In this case the call upon the vents is more gradual, so that they are not over-taxed.

It has been pointed out that the upper "bucks" are nickel-plated. For this to be satisfactorily deposited a close-grained iron is needed. It is found that all the necessary qualities are present in an iron of the following order: C.C., 0.75; G.C., 2.4; Si, 1.5; Mn, 0.7; S, 0.08, and P, 0.4 per cent. Such an iron, cast at the temperature indicated, will give a sound casting free from defects on test and without any open-grained patches on the operating surface in the region of the webs. One of these castings was tested to destruction in the presence of an insurance inspector. It finally burst under hydraulic pressure of 1,360 lbs. per sq. in.

Washing Machinery Castings.

One further example will be discussed here, and that a matter of design. In Fig. 17 is shown a Tullis washing machine. The photograph in Fig. 18 shows a number of green-sand moulds of the outside ends for this machine. In Fig. 19 is a sketch of one of the cast-iron outside ends. It is essentially a circular plate, 3 ft. 4 in. in diameter and $\frac{7}{16}$ in. thickness, carrying the rim for jointing on to the shell of the machine, two feet, and outstanding brackets for the driving gear. The sketch shows an older design of outside end which is seldom built up recently, but it will serve to illustrate a point. As originally designed, the bracket was made separately and bolted on to the outside end. But there are obvious advantages in making the bracket integral with the main casting, the chief one being that of greater stability and rigidity for the drive—usually from a neighbouring shaft. Upon the decision to cast the bracket integral with the casting, it was first designed simply as a continuous plate extended from the body of the casting, carrying the necessary bosses and stiffening ribs.

When machines with these ends were put into service conditions, some of the ends cracked as shown at the dotted line "A." This is a symptom which is evidence of a fault in design, and which in other connections is responsible for a good many failures in service of castings

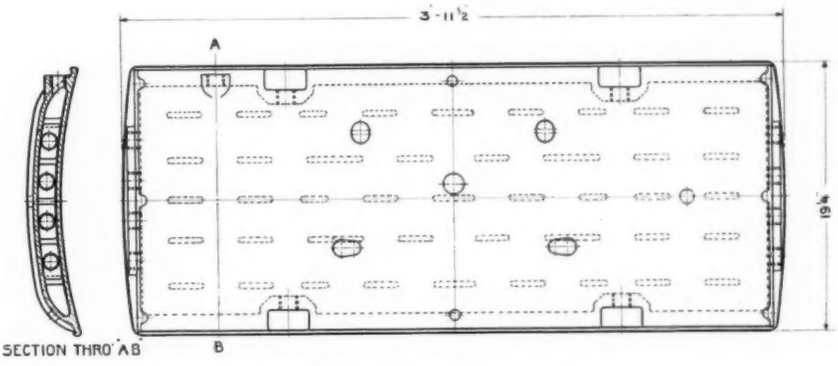

FIG. 15.—PLAN AND SECTION OF A "BUCK."

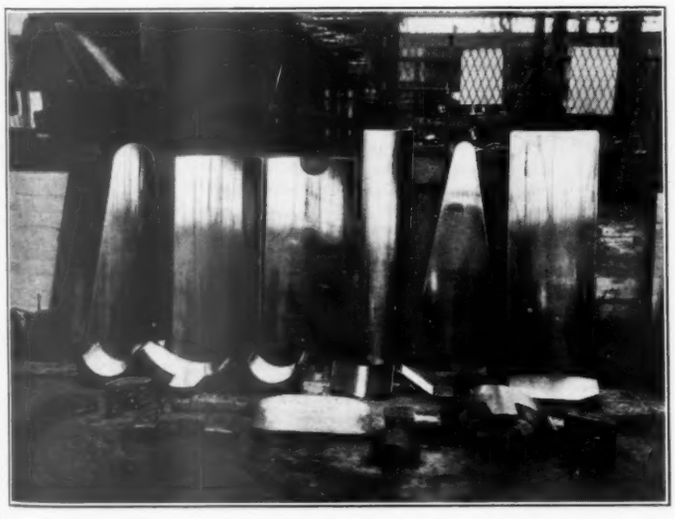

FIG. 14.—TYPICAL "BUCKS" FOR PNEUMATIC PRESSES.

FIG. 16.—MOULDS AND CORES FOR "BUCKS."

of many kinds throughout the engineering industry, wherever such castings are subjected to irregular heating conditions.

In the case under consideration the diagnosis is simple. In service, the interior of a washing machine is brought up quickly to the temperature of boiling water. There follows an equally quick expansion of the whole of the circular

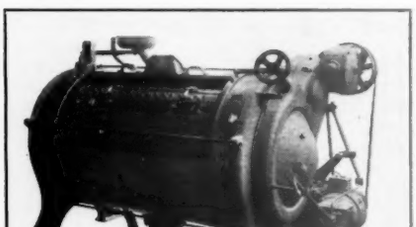

Fig. 17.—Tullis Washing Machine.

plate. But the outstanding bracket remains at or near room temperature, and cannot expand with the circular plate, with the result that heavy stresses are set up in the rim in the region of the bracket, and a tendency to fracture at the point indicated by the dotted line "A" in Fig. 19. The remedy proved simple. The bracket was joined up to the plate by three arms (as shown in the sketch) instead of by a continuous plate. This allowed the bracket to "breathe" in line with the expansion and contraction of the centre plate. In this Paper a few foundry problems in laundry machinery have been discussed, but the list is by no means exhausted. They may, however, be sufficient to demonstrate that this branch of engineering,

Fig. 18.—Green-Sand Moulds for Washing Machine Outside Ends.

like every other, has its own peculiar difficulties and problems to solve and overcome.

In conclusion, the writer expresses his thanks to Messrs. D. & J. Tullis, Limited, for facilities afforded him to discuss and illustrate here some aspects of their foundry practice, and to Mr. D. R. Tullis for the microphotographs.

DISCUSSION.

The Chairman said that he was sure that they were all agreed that they had listened to an extraordinarily interesting Paper from Mr. Longden; he had been very straight and practical in the descriptions of the problems which he had had to solve.

Mr. R. Ballantine said that he had listened with immense pleasure to Mr. Longden's Paper and the descriptions of the methods he used in the making of somewhat difficult castings. He had had the pleasure of seeing through Mr. Longden's foundry and had been impressed by the efficiency of the methods and the quality of the castings produced. There was a point in connection with the beds upon which he was not quite clear. Mr. Longden told them that he used chills or denseners at the bottom of the cores of the webs and he wondered why the chills were not carried right to the top, as he understood that the necessity for soundness and ability to withstand steam pressure there was equally important. Perhaps Mr. Longden would give his reasons for chilling the bottom part only. In connection with the casting with the gills, the photograph of the casting showed an alternate coring of the gills, but in the photograph showing the moulds and method of making up it appeared that the coring was in a direct line.

Mr. Longden, in reply, said that the casting of which a photograph was shown was as a matter of fact one taken some time ago, but they now made them straight as shown in the view of the mould. Mr. Ballantine's question about the chills was important. The reason they used them at the bottom of the web and not the top was the result of observation and experience. Messrs. Tullis got beds back which had been made a long time ago as scrap. On examining them carefully he had never found any defects at the top part of the web, but had often found them in the bottom. Foundrymen, when they had an item of trouble, had to resort to means of overcoming it, and it was a case of adapting the practice to eliminate the trouble. He had never seen one of these beds leak on the top part, and he thought the effect of the shrinkage was different at the top and the bottom. Mr. Longden here explained his views of the shrinkage with the aid of blackboard diagrams.

Mr. D. Mackenzie said that he had been particularly interested in the cylinder and the method of moulding. Mr. Longden had said that the core was made up with straw rope, and he would like to know what thickness was used and the amount of loam. He would also like to know whether any difference was made in the size of the top and bottom of the core to allow

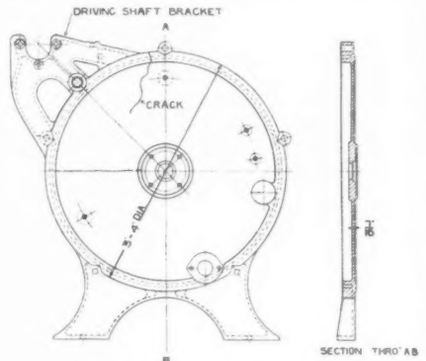

Fig. 19.—Sketch of Washing Machine Outside End.

for pressure. He took it that the cores were run up on a barrel of some sort with a strickle

Mr. Longden said that he would take a 36 in dia. as an example, and proceeded to illustrate his remarks by blackboard sketches. He said they got as big a bar as possible that would pass through the narrow end. Such a core was bound to be built in loam, about 2½ in. thick The straw rope was put on fairly close on the first layer, and, then depending on the type of bar used, a number of rows of hayband, quite 1-in. spaced, the idea being to build up loam behind. He did not build up the different cores with the idea of standing any conceivable hydrostatic pressure which might be exerted. He had never found the necessity for it.

Mr. A. D. Kirby said that Mr. Longden stated that he used an oil-sand mixture of 1 part binder to 20 parts of sand. That appeared to him to be a very high proportion of binder, and he would like to know whether there was any trouble from blowholes. In regard to the roller, which appeared rather thick in relation to the flange, were there any chills used in it?

Mr. Longden replied he did not use chills, as he thought where a casting was thicker than the average, if it was at the bottom of a deep casting, it was more solid than the top. Regarding oil sand in cases like the one referred to, he thought that a little excess binder was necessary. He had never had any trouble with blowholes and would never hesitate to use an excess where the burning tendency was serious.

The Chairman, speaking in regard to the long thin casting for presses which appeared full of webs, said he was not quite clear as to the method of casting. Was he right in thinking that they ran the metal to separate runners to the bottom and then allowed the metal to flow up?

Mr. Longden said that in a way the chairman was right, the metal went down the downgate and then entered by a number of separate inlets.

Mr. A. Bruce said that he had been very much interested in the Paper, which had been instructive in regard to the general making of castings. He thought that the use of denseners in the bottom part of the web of the bed helped to freeze the metal quicker and prevented the drawing from the top part. Referring to the question of the amount of binder in the sand, he thought that an excess was essential in such a case, and it would do no harm provided the core was thoroughly dried. Referring to the cylinder casting, he thought the core bars would not have a very big contraction, but Mr. Longden had

(*Concluded on page* 314.)

The Steel Castings Report.

DISCUSSION AT SHEFFIELD.

As briefly reported last week, a joint meeting of members of the Sheffield Section of the Institute of British Foundrymen and members of the Sheffield Metallurgical Society was held in Sheffield on November 7 to consider and discuss the First Report of the Steel Castings Research Committee of the Iron and Steel Institute which was published in the JOURNAL issues of May 25, June 1 and June 8, 1933. Mr. J. H. S. Dickenson (President of the Metallurgical Society) was the chairman.

The Report was introduced by Dr. H. Moore (chairman of the Research Committee) and by Dr. R. H. Greaves. Other members of the Research Committee were present, and there were many visitors, including engineers and members of the Foundry Trades' Technical Society.

Lack of Co-operation Deplored.

MR. W. T. KITCHING (Branch-President) opened the discussion. He referred to the suggested liaison between designer and producer. He said he found that in the design of all castings, particularly steel, the draughtsman had never had sufficient foundry experience in order to design to suit the foundry and the machine he was building. A draughtsman had his job to learn, over a period of years, but probably he was without any foundry experience, and he thought engineers would be well advised to pick designers of castings from men who had had considerable practical foundry experience.

At one time, when he made castings of special types, he always thought how comfortable it must be to run a business where someone else made the castings, and he had only to machine them and fit them together to form the machine. Now he ran a business where they made castings, but also bought a considerable amount of semi-finished material to work up into other machines, and he found he was right in his previous surmise that the man who had not castings to make in his business was fortunate. Making castings in all branches of engineering was a most serious and worrying problem, because they often came across cases where they could not tell why a casting had failed.

PROF. ANDREW, of the Sheffield University, had realised the lack of adequate foundry personnel, and he was inaugurating at the University a course giving men practical foundry experience which the speaker was certain would bring great benefit to engineers. Experience in actual founding would show itself in design of castings when the young men took their places in industry.

MR. MERCER said the Report was interesting in dealing with difficult and intricate castings, and he thought the Committee would have received an education during their investigations in the steel foundry, and would now realise some of the troubles encountered in the production of difficult castings. In the pattern shop and machine shop, the craftsman could visualise his job in the shape of wood or metals. In the steel foundry, the number of things a moulder could omit or commit were innumerable, and unless a man had the necessary intelligence and training, disasters occurred despite the knowledge possessed by the foundry management. The Constantine College at Middlesbrough had a foundry course, and was doing good work. Every effort was being made to get foundry apprentices to attend these classes.

Practical Dodges.

Four or five years ago he had to overcome a number of the difficulties mentioned in the Report, and he cut out all brackets and introduced chills with taper edges wherever it could be done. In regard to the shrinkage holes which appeared in, say, cylinders cast horizontally, he found a good method some time ago—cast from one end and immediately the steel is up in the head at the opposite end, take the ladle to that end and draw the steel back through the runner. This distributes the heat of the steel more evenly and eliminates the Vee-shaped segregations, "hot pulls," and shrinkage cavities. In referring to the core of the cylinder, Mr. Mercer said that in the examples shown in the Report, a core barrel, 7 in. in diameter, was used, wrapped with straw rope and then the core was struck up. He thought it better to use oil-sand cores, as he had done in cylinders weighing 9 tons. The surface of the core was then immediately "friable" and allowed the casting to contract. He was very surprised to see that one cylinder was run with a series of runners all the way up the body. This tends to "cold lapping," and, of course, "hot pulls." His practice was to run from the bottom only, and as soon as the steel appeared in the feeding heads, fill these up with hot steel. In addition to oil-sand cores, it was a good idea to mix sawdust with the sand round feeder heads. This relieves the heads by the sawdust burning away and allowing the heads free movement, thus eliminating the chance of the moulder failing to "ease" at some particular point.

A Comparison with Ingot Making.

If steel be poured into an ingot mould, the sides of the mould chilled the steel and it "settled," but if the same steel were poured into a sand mould a spongy casting might result. He did not know the opinion of the Committee, but his view was that, having to cast with a much hotter steel, a much larger amount of silicon was necessary, and this caused spontaneous heat after the head had set, resulting in defects in the sections.

On the subject of contraction pulls, as a foundryman he considered they must have "body" in the steel. Some years ago he had seen steel made from rubbish and yet having correct analysis, with low sulphur and phosphorus. When it came to a question of bend tests, the steel was hopeless. If good steel were obtained much of the trouble would disappear. He was of the opinion that steel should be poured hot and run into the mould as quickly as possible. MR. MERCER also commented that he missed from the Report any reference to bend tests. DR. GREAVES had said it would be better if they had the money to spend on experiments in castings. He (Mr. Mercer) might also state it would be a long time before a ship was launched if the Engineering Department waited for the production of the "perfect" castings they sought after.

MR. MERCER thought they ought to thank the Committee for the way in which their work had been done, as, whilst to the experienced foundry manager there was not a great deal to learn from what was put forward, to the beginner it was certainly an education to go through the report and would help them to avoid some of the defects shown.

Contraction Differentiation.

DR. P. LONGMUIR said the Report would be welcomed by all steelfounders and students of foundry practice. The conclusion that every new design of casting was virtually an individual problem was interesting, in that in 1907 McWilliam and Longmuir had stated that each new piece to be cast formed a new problem. It was therefore comforting to find a similar conclusion reached in 1933. In the Report there was no differentiation between liquid shrinkage and solid contraction. If they regarded any fluid metal as a liquid liable to the conditions governing fluids approaching solidification, they would then get a cue to many of their problems. Once liquid shrinkage was complete, no further cavities were formed in any type of metal.

In dealing with solid contraction, they had the weakness of the metal in its first stage of solidification to consider, and for that reason moulders knew that very often a casting could be cracked by the method in which it was gated. The previous speaker, Mr. Mercer, in mentioning one of the cylinders, had referred to the side gates. Once these gates ceased to be effective as feeders, they would, as shown in the Report, tend to pull the casting, and that pull would come on the metal of the casting when it was in its weakest condition.

The illustration of an oil-sand core given by the last speaker was a good one, and they all realised that pulls could be effectively prevented by arranging cores or any binding part of the mould to yield to the contraction coming on to the casting. Dr. Greaves and his colleagues were to be congratulated on the admirable work contained in the first Report, and he hoped that when they extended their research the metallurgical side would be supplemented by work on the actual foundry side.

The Price Factor.

MR. J. A. E. WELLS endorsed the suggestion as to the need for greater co-operation between drawing office and the foundry, and said it was equally important there should be even greater co-operation between the Admiralty, War Office and the Foundry. The practice, generally speaking, of accepting the lowest tender was in many cases responsible for the failure of material to meet the specification, and only by changing this policy and more intimate contact between the parties concerned can founders hope to achieve the results so much desired by all.

He noticed in the Report mention of a number of crane cylinders, and would like to know if the Committee, before carrying out research on these castings, knew that they had been previously supplied satisfactorily. If so, it would appear time had been wasted in carrying out research upon castings which obviously had been made in the wrong manner.

A New Theory.

MR. VICTOR STOBIE said it was necessary again to stress that the Report was not made either to prove or disprove that sound castings could be made, but why, when there were defects, these had appeared. He would like to question the Committee, or dispute with them, on some conclusions drawn regarding defects. He referred to Figs. 12 to 15. It was said that when there were defective corners, as on these, the defects were due to blows from the mould. That theory was sung as a kind of hymn in many foundries, but he certainly thought it was "Ancient" and not "Modern." Was it not a fact that when steel first entered a mould and touched the green-sand surface then would arise the highest local pressure of steam and air? If they could not get away through the mould and the small amount of metal then at that position, there would be an explosive action. In that case, there would occur a disruption all around and not a kindly blow in a single direction. Was it not probable that the eutectic iron oxide present in the steel, gathered from air and steam in the mould if from nowhere else, pressed forward to the last setting part of the casting as the metal in the thinner parts froze? That would increase the iron oxide in the thickest part and, by its great excess, cause the defect. They would find these defects in the corners of thick flanges where steam and air could get away comparatively easily. Mr. Stobie submitted they got the defect usually where the metal was longest in solidifying, and it was the result of iron-oxide segregation. One noticed in ingots a drop in the oxidisable elements, with the usual exception of silicon, in those parts of the ingots where

the steel froze last. This, and the oxygen-caused defects in such parts, would tend to support the present suggestion. An ingot head, however, is subjected to several other factors, which make it not necessarily a guide. The axial portion of the ingot offers the best illustration.

In regard to internal cavities, he thought it would be useful, as they could not all have X-ray apparatus, to take the specific gravity of all very important castings. He thought that method might be considered by the Committee.

Brackets or Chills.

In the case of brackets, Mr. Mercer told them that he took away the brackets and put in chills. Did brackets necessarily add strength to the red-hot casting in the mould? The dangerous time was when the material was solidifying and just about plastic. That was when "pulls" mostly occurred. It seemed possible that the advantage might be that brackets broke up the continuity of the mould and ensured white-hot metal around additional parts of the sand at the bracketed part, and so the clay bond was destroyed a little quicker than it might otherwise have been, thus releasing the casting more easily.

Retarded Cooling Suggested.

Mr. W. Barker said that if he had to make the type of casting dealt with in the Report, he would certainly use a sand which would give as soon as ever the steel came in contact and at the same time give resistance, so as to avoid scabbing. In regard to the method of moulding for a casting such as was exhibited, he would certainly not use any bars in a box part or use a box at all for covering the mould. He would have the top covered by a core made in a grid to enable the breaking away of the covering core and to remove the casting quickly. He would not allow the casting to cool in the atmosphere, but it would be put into an annealing furnace, which had been recently emptied, and allowed to cool there.

In regard to the heads and runners, he was rather amazed by some of the examples of castings which were given. Some of the heads would be set before the casting thought of setting, so of what use were they? They caused cracks and also made the steel porous all through the casting, because of insufficient feeding head. Heads on other castings created such an irregular rate of cooling that pulls or tears were bound to occur.

He would have no ingate in the actual casting, but through one of the heads. If only having one head, he would have the ingate in the head. He certainly would not cast such castings as were shown on end. It had two flanges and, if stood on its end to cast, as soon as solidification started to take place, it would be found that the casting "starts to hang itself and tears or pulls itself all over the place." He would cast so that gravity would do the feeding and have one head at the highest part, with the ingate attached.

In respect to the metallurgical side of the question, usually people who wanted castings like those they were discussing wanted a mild steel resembling boiler steel as much as possible. In a foundry it was found that a steel of low carbon and silicon had to be cast quickly and the core giving out a great deal of gas, the mould became full before the gas got away, and a kick was caused in the metal, thereby creating, from his point of view, the major part of the troubles found in these castings.

Co-operative Research.

Dr. J. G. A. Skerl added his modicum of praise to the members of the Committee. For the first time they had some semblance of co-operative research amongst steel foundries, and he thought they had reached a stage, in this country, when it was becoming essential. There were very many points in the Report which could be discussed, but there were two matters which struck one very forcibly. The first was the differences in the types and position of heads and runners in the various makes of castings, and the second was the preponderance of cracks. He thought the Committee could do a great deal of good if they worked along the lines of finding out the best types of runners and heads for different types of steel castings. Much had been done in certain foundries, on runners particularly, and there was no doubt at all that certain types of heads were more satisfactory than others. Such types did not seem to be represented on any of the castings shown in the Report. He stressed the importance of heads because they solidified before the casting, and the weight even of a runner was sufficient to cause the cracking which was such a feature of many of those castings, especially on flanges. Another point which had been stressed by other people in the discussion was the fact that nothing, or very little, had been said about the moulding conditions of these steel castings, and it could not be stressed too strongly that the material which formed the cores in particular, as well as the mould, had a very pronounced effect on the resulting casting. He could visualise that at least half the cracks were due to faulty conditions in the cores, and a large proportion of the remainder due to runners. Some research should be carried out on materials which should give efficiently to the contraction of solid steel and also be strong enough to stand the wash of metal. Oil-sand cores had been mentioned, but he did not believe they need go altogether to the expense of such materials. Organised co-operative research on steelfoundry sands was essential. Some point had been made in the Report on the economic position. There was one table which should be given, although he did not know whether it would be possible to give it. That table was the relation between the percentage weight of heads and risers and the cost of the casting. He thought that would show a light on the mentality which was creeping over the steelfoundry industry to-day. Competition was such that the price of the casting had to be cut to such an extent that risks had to be taken, and very often that risk was in the direction of reducing the heads and runners. One had to face the fact that the selling price of a casting was a very considerable matter when discussing soundness.

The question of the metal had been dealt with very thoroughly, but one point Mr. Mercer had made was that analysis of metal was not sufficient to show whether it was good enough for a steel casting. It was certain that a mere analysis was nowhere near sufficient. Too often in steel foundries there was separate control of the moulding and melting operations.

Draughtsmen's Training.

Mr. Bool said he was rather interested in the question of the liaison of the engineer and the foundryman, and asked at what age would the draughtsman begin to learn his own job after he had learned all about the foundry? He thought that suggestion was ridiculous. He would say, however, that if a draughtsman thoroughly understood the manufacture of a cast-iron angle plate with brackets at the ends and broke it up and thoroughly examined its structure microscopically he would know very nearly all he would need as a designer of castings, and that would not take very long.

He would never use brackets if he could possibly avoid them. He really felt that foundrymen generally would do well to do as other trades were doing and advise their customers as to the best way of making a casting and let them say on the receipt of a drawing immediately what the position was, referring the matter back if they thought the design was not very suitable, or could be improved, from a manufacturing point of view. They could suggest making the casting in some other manner which would result in a more favourable price and help them to get the work. He would say that it was a common practice to put on a certain percentage for wasters, but if the foundryman was satisfied that he could make a casting if the design were right then he would let him have the design modified, just as happened in any other structural work. Most trades, for instance, would say that cracks appeared because the design was wrong, but if they knew it was wrong it was their duty to say so beforehand. He believed they should take the responsibility rather than say the designer was inexperienced and therefore could not make the drawing. It was quite the fashion to say that if the engineer only knew his job the metallurgist could make the steel.

Rapid Teeming Advocated.

Mr. R. C. Tucker said that in a complicated casting the slow filling of the mould would inevitably make a short run. The quicker they could get the metal in, the more uniform or solid throughout was the metal. An unequal distribution of heat meant running round with a ladle to the riser, which would tend to overcome that unequal distribution. But if they could run it through the same ingate, they got the same effect with much more certainty.

It was said that the scientist had no place in the steel foundry, because he did not tackle a job in the same way as the practical foundryman. But if the two of them worked together, they were much more likely to get a sound job than if either of them did it in his own particular way. The scientist could not possibly understand all the practical details that went in the making of a mould, unless he had been apprenticed to a foundry, by which time he would probably be about 30 years of age, and if he then started learning science, he would not get very far.

It had been stated that the Report did not cast any slur on the British steelfounder, but he (the speaker) rather thought that it did cast a slur on the large proportion of the steelfounding industry that so many reputable firms—it was presumed they were reputable as they were supplying the Admiralty—were using disreputable methods of moulding and running a casting. There were certain well-known principles in founding, but they were up against two contending influences—one the formation of blowholes and against that the formation of cracks. They had to strike a happy mean, and firms that went all the way in regard to stopping blowholes definitely did not know their job. If people would realise that there was more than one influence in the making of a sound casting, very much better castings would be made, and that was where the scientist came in. He kept everything constant but the thing he was trying to vary and found the exact magnitude of effect of any one variable.

Radiated Heat.

Mr. C. D. Pollard referred to previous remarks "of a typical engineer." As an individual representing the steel-foundry trade, he would say they were longing for the opportunities of putting the foundry point of view in front of the engineer. One of their difficulties was that once having received a drawing they had to put their opinion through the buyer. He would ask that, as far as possible, they should encourage more co-operation between the buyer and the engineer on the purchasing side. They tried to get co-operation in the foundry itself, and if a little more spade work could be done the purchasing engineer would probably have the opportunity of putting his view forward before the foundry made unsatisfactory castings. As a constructive suggestion, he would submit to the Committee that in going further into the investigation, thinking particularly of the drawing office and the young men coming along, he would suggest that the radiation of the heat from the steel poured into the mould should be brought more to the notice of the young men. He thought that if they could get the drawing-office people to realise the

effect radiated heat had on the moulds, they would get the draughtsmen thinking on the right lines.

Foundry Science Degree Course.

Prof. J. H. Andrew said he regarded himself as a listener rather than a contributor to the discussion. But since there had been made remarks in regard to science and experience in the foundry, he would say that no one more than himself believed in sound practical experience. However, experience could only lead to opinion, and since there were many people who gained experience, they were bound to have many opinions, whereas the ultimate aim of science was to obtain facts. He thought it was essential that they should begin to apply scientific instruments and viewpoints to foundry practice. At the Sheffield University they had the inauguration of the foundry science degree course, and he really thought it was time that such a course was started.

The Sample Casting.

Mr. J. R. Hyde said he was very pleased to see Prof. Andrew present, and he thought it was high time something further was done to help the foundry to get down to facts. No doubt the University scheme would help to clear up some of the problems which were of great interest to many of them. A long time ago, at a meeting of the Institute of British Foundrymen, a respected manufacturer of steel castings said, "You cannot feed a thick section through a thin one," and he still believed that premise was almost a fact. To-day they would say that it was difficult to feed a thick section through a thin one. If they could get one or two more of those axioms postulated and then another attack on those difficult castings they would probably get more satisfactory results.

One criticism of the Committee's Report was that they had not controlled the variables sufficiently. They took two castings from a foundry, possibly from the same heat, but that was hardly sufficient to form a judgment upon. He knew it was a question of expense, but it should be possible to take several representative castings from the same heat of steel to see really where the influence of casting temperature was most noticed. The question of variables was one with which he had the greatest sympathy. In his own experience he had tried, when receiving any report, to find how many variables they were discussing. Another remarkable thing which he wondered whether Dr. Greaves had ever noticed or not, was that the first or sample casting was generally either very good or very bad. To his mind the reason the sample was satisfactory was that the heads of the foundry, or the brains, went down and looked at the job, whereas when bad it was left with somebody else. He was sure they could make these castings in this country, but it was a question of when it was a commercial proposition. Therefore, he welcomed the suggestion of getting a larger number of trained men who would bring a trained mind to bear on the job.

Mr. J. A. E. Wells said he was sorry to hear the last speaker make such an admission, that invariably sample castings were good and the remainder probably unsound. It should be impossible for such a state of affairs to exist in any well-conducted foundry, and such a statement was a slur on the foundry trade.

An Ironfounder's Views.

Mr. J. Roxburgh said he was not a steelfounder, but was engaged in the manufacture of iron castings. He had derived great interest from comparing the method of manufacture of steel castings with that of iron castings. The particular casting exhibited on the blackboard, if it had been submitted to the ironfounder, would not have been considered difficult to make. They would have moulded it horizontally and then tipped it up vertically and cast it with about 2 ft. or 2 ft. 6 in. of head and run it with eight or nine runners from the top down the thickness of the metal. He thought the various methods suggested and the number of runners on the casting would unduly complicate the manner of casting by creating hot spots and also trouble by contracting. Was it found that the most successful casting had been cast vertically in a manner similar to that he had outlined?

Science and Art in Steel-Foundry Practice.

Mr. Dickenson (chairman and President of the Sheffield Metallurgical Association) said the Committee must be indebted to the contributors to the discussion. Obviously, the discussion was going to be a very great help to them, and he thought they would have to consider carefully some of the observations. There were numerous technical points to which Dr. Greaves would reply, but he (Mr. Dickenson) would like to touch upon the application of science in the foundry. One speaker had said there was no such thing as scientific knowledge in a foundry. If that were true, it was not a thing to be proud of. Scientific knowledge, after all, meant the common-sense and systematic co-ordination of facts, and he did not think any foundry could be run any more successfully than a fried-fish shop without such a basis for its operations. It was true that at present foundry work—and he referred particularly to the moulding part of the process and not to the steelmaking—was to a large extent an art. Art was a very good and necessary thing in its place, but to be wholly dependent upon it without scientific method was bound to cause continuous waste of time and material. Of course, it was true, as had been suggested that night, that every new form of casting constituted a new problem, and there was not always sufficient linkage or resemblance between old solved problems and a new case to provide clear indications as to the best way of proceeding, but he felt that if such cases were dealt with on truly scientific lines, and if they had a good deal more science than at present in a foundry, all difficult cases being noted and correlated, there would be far less improvisation and far fewer failures. No doubt it would be long before they would be in a position to lay down strict rules, to indicate clearly how any given casting of new design should be made, but he did submit the effort should be made.

As regards the series of castings dealt with in the Report, it was, of course, open to anyone to criticise in any way they chose the various methods of moulding and casting employed, but, as one speaker suggested, the Admiralty bought its castings from reputable firms and, in fact, all the castings were made in foundries of reputation and standing. The probability was that any one of those foundries would have made a much better job the second time.

Influence of Method of Manufacture on Final Results.

The important point was that the Committee, having asked various individuals in several foundries to put forward their proposals as to the production of the selected casting, and having received as many different answers as there were requests, decided it would be most interesting to compare the results in each case. He believed that if the same proposal had been put to all those who had taken part in the discussion that night, they would have had as many more different ways of making this particular casting, and he thought it not a little unlikely that those gentlemen who now said "If I had made it I should have made it so-and-so" would have ended up in much the same way as those who actually contributed. He believed that the key to the whole situation was that it was theoretically and practically impossible to cast some of the complicated shapes now required completely sound in all parts, for the reason that it was impossible satisfactorily to run or feed a thick or heavy section through a thin one, as Mr. Hyde had suggested.

Castings were now required to be made of forms such that it was quite impossible to feed all parts, and those parts not fed were found to cause shrinkage cavities if the steel was free from blow-holes. In making some castings, one was between the devil and the deep sea—that was, in certain complicated castings—for they had either to have shrinkage cavities due to the contraction of steel as it froze and cooled down or there must be blow-holes, and he was not at all certain that there was not something to be said for blow-holes in certain cases.

This brought up a practical point. He supposed that many steel castings of complicated form would on examination be found either to contain blow-hole cavities or shrinkage cavities, but he was equally satisfied that these castings served their purpose perfectly well. He thought that an outstanding feature in connection with steel castings was that, although there was so much trouble in satisfying inspectors as to test results and surface soundness, castings when put into service caused so few cases of failure or trouble, and there was no getting away from the fact that steel castings made in the foundries of this country gave excellent performance in service. He thought that many suggestions arising in this discussion would guide the Committee in its further work.

Training the Entrants.

Finally, he would like to refer to the training of foundrymen. In his view, as he had said, the foundry needed science badly and could only be made scientific if operated by men having scientific training. He was not quite sure what the training should be, but even a relatively elementary training in foundry practice, added to a general metallurgical and scientific training, would be of enormous assistance when the student had the opportunity of widening his experience, developing his ideas and carrying into practice the methods of exact thinking in which he had been trained. He was looking forward eagerly to seeing the products of Prof. Andrew's labours in this direction, which should be very valuable indeed.

Cast Vertically yet Unsound.

Dr. R. H. Greaves said he could not pretend or hope to answer all the many questions put forward in the discussion, but there were one or two points to which he would like to refer. To start with, a remark was made near the end of the discussion in regard to the effect of casting their experimental casting vertically on analogy with the practice in connection with cast iron. Actually, in one instance it was cast vertically, but this was not very successful. It was bottom-run by means of a vertical runner with side runners at three positions, the heads being placed at the top. That casting was free from cracks, but suffered a considerable amount of unsoundness. It might possibly have been better with the heavier metal at the top, but the method most successful of all was to cast it horizontally with the three-branch side upwards and heads properly disposed along the top, the weight of heads being about 40 per cent. of the metal cast.

Some reference had been made to the crane cylinders, and suggestions made as to research which might have been carried out in that connection. He would remind them, however, that the cylinders were part of the preliminary work of the Committee, and it was only in order to survey some of the defects coming forward in steel castings in supply that the cylinders were examined. It was quite likely that they were made successfully by many firms, but only those put forward against one order were examined and a record made tracing the connection between defects, general structure and method of casting.

Reference had been made to the absence of bend tests. These had been made in a good many instances, but they were not included in the tables. In connection with the very mild steel, the bend test was satisfactory, even before the casting was annealed. They could get result-

up to 120 deg. The Izod figure also was not bad in low-carbon steel before annealing; it was about 12 ft./lb., which was nearly as good as in the higher tensile steel which had been annealed.

Mr. Stobie had put forward an interesting theory in explanation of an effect which they had put down to severe blowing. The suggestion was that it was not blowing but segregation of oxide. It seemed to him, however, that if the effect was due purely to segregation of oxide, there must have been more oxide in the steel than would be expected, because the amount of decarburisation in the region of the blow was very extensive, and the amount of oxide present microscopically was considerable.

Specific Gravity Tests.

Another suggestion was that the specific gravity of steel castings should be taken more frequently. That might be very useful in the case of small castings. It was done a great deal in the non-ferrous industry, with useful results. Although it might show the presence of cavities and blow-holes, it would not reveal the more serious defects like cracks which were often of very small thickness and only opened out when the casting was stressed.

He would like particularly to thank Dr. Longmuir for his remarks, because he thought the foundry industry owed a great debt of gratitude to him. Dr. Longmuir had directed their attention to the importance of ascertaining more definitely the physical properties of the materials and the influence of these properties on behaviour in the mould. He thought that was a point which had got to be put in the forefront of the future work of the Committee.

It struck him that the discussion as a whole was extremely useful and practical, said Dr. Greaves, and he thought when they got the full report of the discussion (taken exclusively by the representative of The Foundry Trade Journal) the Committee would not have any difficulty in finding a number of useful suggestions which might be followed up and possibly incorporated in their work.

Dr. Moore said this was only the first Report of the Committee and must by no means be regarded as a complete guide to the manufacture of steel castings. The Committee considered that it had far more work in front of it and was anxious to have suggestions. Indeed, it was to discussions of that sort that they looked for suggestions, to be considered together with those already under discussion, by the Committee.

He would like to refer to what one speaker had said about Commander Sedgwick's views on steel castings. He had the greatest respect for the Admiralty, a Department with which he had had the privilege of working closely for many years, but the idea of taking responsibility for everything the Admiralty did or said filled him with horror. He had not heard previously that Commander Sedgwick said that the average steel casting consisted of one-third nails, one-third welds and one-third steel. He (the speaker) regarded this statement as distinctly unfair to the steel casting; he would put the proportion of steel as two-thirds!

Defects in Arc Welding.—In Report No. 239 of the Materials Sub-Committee of the Association of German Ironmasters, published in the "Archiv für das Eisenhüttenwesen," F. Leitner discusses the effect of the basis material on the production of defective places in arc welding. Experiments show that a high-welding velocity and rapid solidification favour the formation of pores, while high-current strengths inhibit this action. Furthermore, the presence of silicon favours pore formation, and its absence prevents it. A high-silicon content in the material being welded again causes the pores to disappear, the same effect being produced by a high-manganese and an increased carbon content. The minimum content depends on the welding conditions; in the experiments described the limits were found to be 0.4 per cent. carbon, 0.6 per cent. silicon and 1.7 per cent. manganese.

High-Frequency Furnaces and Their Services to Industry—1923-1933.

By G. R. Webster.

The steady improvements in high-frequency furnace efficiency which have resulted from the improvements in design and methods of operation introduced in recent years have contributed to the present undoubted successful production of new alloys, and metals of much superior properties.

The first high-frequency plant of its kind to be erected in Europe to be used for production purposes was at Bilston, Staffs; the plant consisted of 42 furnaces each of about 20 lbs. capacity. Fig. 1 shows a view of these furnaces.

Fig. 1.—A Battery of 42 High-Frequency Furnaces installed at Bilston.

The equipment consisted of a high-frequency converter, including a high-reactance transformer for stepping the voltage up to that required for charging the condensers, a bank of condensers and a spark gap consisting of two electrodes arcing on to a mercury bath in an atmosphere of hydrogen.

Fig. 2 shows a single furnace and the necessary instruments and switchgear.

These furnaces were used to produce the now well-known nickel-iron alloy Mumetal, which by careful exploratory work it was found had very remarkable electrical properties. In consequence of these properties the use of this alloy rapidly developed in the construction of ocean cables. These cables, loaded with Mumetal, are capable of transmitting to a capacity equal to that of four of the older types of cables.

Furnace Progress.

The development of new alloys, however, created a situation which was something beyond

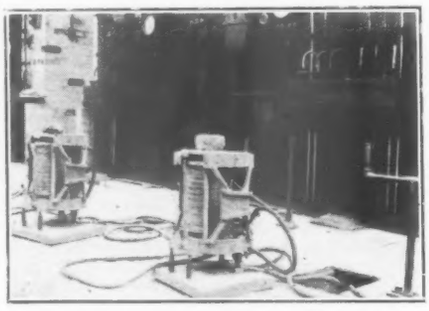

Fig. 2.—A High-Frequency Furnace with the Necessary Switchgear.

the scope of these small 20-lb. furnaces. Except in a very few special cases, such as in the melting of the rarer metals, or for research activities, these small spark-gap type furnaces have been generally replaced by the motor-generator-operated larger type; at first by the furnace of about 5 cwts. capacity, and in more recent developments to furnaces of 4 to 5 tons capacity, used for the production of high-grade alloy steels.

Two motor generators, supplying two furnaces, in one case, 160 k.v.a., 1,000 volts, 500 cycles, 1,500 r.p.m., and the other 150 k.v.a., 1,200 volts, 2,200 cycles, 3,000 r.p.m., have now been running in the works with which the author is connected, on day shifts, and intermittently for 24-hr. shifts for approximately five years, with no more attention than would be given to the usual works electrical plant.

Furnace Linings.

A comparatively recent development is in connection with the lining of these furnaces. The fireclay or plumbago crucible was unreliable, of very uncertain life and costly. The method of making the newer lining consists of a refractory powder, either acid, basic or neutral, rammed between the furnace coil and a metal template corresponding to the approximate size of the finished lining desired. The first charge is placed into the metal former, the former or template is heated by induction, and the refractory powder is fritted by the time the former is molten and incorporated in the first charge, to a sufficient thickness to allow of continuous melting. The number of heats obtainable from this type of lining vary with the kind of alloy to be melted, the condition of the scrap (if scrap is used), whether continuous or only intermittent melting is carried out, whether the lining is acid, basic or neutral, and the time taken in some refining operations.

The success of the fritted lining has been so definite that it is rapidly becoming more universally used, although the proper grading of the refractory lining material cannot be stressed too much, and by no means less important is the care with which the first fritting and melting is carried out. Many linings of this type have failed because proper precautions have not been taken in their installation. Linings of a special section brick are also proving successful, the life of linings made in this way being approximately the same as are obtainable from the fritted type.

The irregular losses and difficulty of working to definite limits of analysis met with in many other methods of melting, is not found with the high-frequency furnace. The whole bath of metal, of uniform composition can be controlled within very narrow analysis limits, and the melting losses kept constant.

"Special" Steels and Other Alloys.

One of the largest fields in which H.F. furnaces are employed to-day, in which the contamination from fuels or electrodes is so essential, is that of the production of electrical and magnetic alloys containing large percentages of nickel of the Mumetal type, the 80/20 nickel-chromium heat-resisting metals, the stainless steels, radio loud-speaker magnet steels and the iron-aluminium alloys with about 10 per cent. aluminium, which withstand service in highly-corrosive atmospheres at elevated temperatures possessing considerable mechanical strength.

Investigations which are being carried out with increased success, both on the Continent and in this country, with vacuum melting of metals, lead one to expect rapid commercial development of the H.F. furnace for this purpose. Because of the greater uniformity and dependability of the alloys produced in the H.F. furnaces, there is no question that the use of these furnaces will continue to expand.

Thermal Properties of Refractories.—According to the work of F. H. Norton, the stability of refractories to temperature changes is directly proportional to the thermal conductivity of the material and the mean distortion at low stresses and inversely proportional to the mean coefficients of thermal expansion. In the "Glastechn. Berichte," K. Endell describes further work on the same lines, with special reference to other physical properties of refractories, and obtains results which are in agreement with practical measurements and observations.

XUM

Czecho-Slovakian Foundry Practice.

MORE PERSONAL IMPRESSIONS.

A meeting of the London Branch of the Institute was held at the Charing Cross Hotel, London, W.C.2, on Wednesday, October 4, the Branch-President (Mr. C. H. Kain) in the chair.

The minutes of the preceding meeting were taken as read, and were confirmed and signed.

Appointment of Delegate to General Council.

By virtue of the election of Mr. V. Delport to membership of the Institute's General Council at the last annual convention of the Institute, his office of Branch Delegate to the Council became vacant. On the motion of Mr. Delport, seconded by Mr. W. O'Keefe, Mr. Turner was unanimously elected a Branch Delegate to fill the vacancy.

The International Foundry Conference in Czecho-Slovakia.

A Paper on this subject was presented by Mr. T. Makemson (Secretary of the Institute and Hon. Secretary of the International Committee of Foundry Technical Associations).

Sand for Non-Ferrous Foundry.

Further information on Czecho-Slovakian foundry practice was disclosed in the discussion on Mr. Makemson's Paper, published in our issues of October 19 and 26, 1933. The discussion was opened by Mr. V. C. Faulkner (Past-President of the Institute), who attended the international conference. He supplemented the Paper with further information. In the first place, he mentioned that in the magnesium alloy foundry of Ceskomoravska-Kolben-Danek, and in the brass foundry of Skoda, there was constructed over the whole of the moulding machines a gangway on which the labourers filled from barrows the sand bins above the machines. Mr. Faulkner added that he had seen the same system in operation in France, and it was quite a good system of supplying sand to moulding machines where not too much was used. In the iron foundry at the former works there were roller conveyors leading from the machines.

With regard to production, he said that at one works an adult male worker was making, with the best of equipment, cores which were about 2 ft. in diameter by 2¼ in. square, and his piecework-time allowance for the job was half an hour. On the other hand, in at least one foundry in this country girls aged between 18 and 21 years were allowed a quarter of an hour for the same job, and could make time and a-half.

High-Phosphorus Iron.

A feature of Czecho-Slovakia to which Mr. Faulkner called particular attention was the almost complete absence of high-phosphorus iron, and as the result of that one did not see any cast-iron gutters or fall pipes in the country. Such products were stamped out of sheet metal, except that the fall pipes, at the point where they met the ground, were of cast iron, but of much heavier section than those used in this country. A good deal of the requirements of Czecho-Slovakia for really high-phosphorus iron were still imported from this country. At an exhibition in Czecho-Slovakia he had noticed that the stoves for use in country houses were of a much heavier character than those used in this country, and were quite unlike the German or the French types of stoves; they were very ornate, and the heaviness of the section was due to the absence of high-phosphorus iron.

At the First Engine Works, at Brno, Babcock boilers were being made under licence, and some very fine turbines were also being produced. Normally these works employed about 4,000 people, but the number employed now is only about 400; that was typical of the conditions in Czecho-Slovakia, with the exception of the Skoda works, which he believed was operating at about 30 or 35 per cent. of capacity. Until two years ago Czecho-Slovakia was enjoying prosperity equivalent to that of the United States. As had been pointed out by Mr. Makemson, the Czechs had to convert Prague—an ordinary provincial city—into a big capital city, which meant the erection of Government buildings, embassies, etc., they had had to create and equip an army as big as that of Britain, they had to take over the railway system, and so on, so that for quite a long time they were busy with internal work. As for their export trade, if it was a fact, as he was informed it was, that Czecho-Slovakia was supplying castings for the British, French, German, Italian and American navies, it was a good record for so small a country.

Emulating Sheffield Practice.

At a works at Storek, which specialised in the manufacture of steel and malleable-iron castings, they used for the steel castings some ready-made alloys imported from Messrs. Firth, of Sheffield, and they had also imported from Sheffield a crucible melting furnace and the method of making the white crucibles used in that trade. They were making castings with such materials as Firth's "Staybrite," under licence, for local markets. A feature he had noticed in the malleable foundry there was the use of some old railway tyres for annealing pans; this seemed to be an economical method of using up these tyres.

Commenting on the making of scissors, which had been referred to in the Paper, Mr. Faulkner said he had never seen anything more cleverly produced than some scissors he had seen at an English foundry recently, having the words "Made in Sheffield" cast in.

Emphasising Mr. Makemson's remarks concerning the foundry control department at the Skoda works, he said the composition of the metal, the risers and the places at which they were to be used, and everything else, was fixed before the job went into the foundry. Such a system must be adopted in this country if we were to emulate the international reputation that had been built up by the Skoda works.

Moulding Sands.

Another feature to be noted throughout the foundries of Czecho-Slovakia was the use of green-coloured moulding sands (such as those used in the Ruhr) for all the lighter steel castings. The reason for the green colour was that the sands contained the mineral Glauconite, which, in theory, should lower the refractoriness, but it seemed to serve very well in practice. For the heavy steel castings they used "Chamotte," but he had not been able to find out what that was. He had noted, however, that it was the practice at the Skoda works to mix with the "Chamotte" at least 2 per cent. of graphite; he was informed that they would like to use 4 per cent., but that it cost too much. It was standard practice to use graphite with this material, but he could not find out the reason why. It was also the practice to paint all the moulds with a mixture of silica flour and china clay, and that seemed to give a very good surface.

Labour, Sand Handling and Control.

Mr. G. E. France, after complimenting Mr. Makemson on the interest of his Paper and the attractive manner in which he had presented it, said he would have liked to have heard something about the labour conditions and labour costs in Czecho-Slovakia, because we in this country were interested in comparing not only the methods of manufacture used in Czecho-Slovakia, but also the costs of production, with our own. Another important consideration was that the fuel conditions in Czecho-Slovakia were very different from our own; the staple fuel used in the steelworks there was lignite, which had a tremendous influence on metallurgical conditions.

The practice of delivering moulding sands to the moulding machines by means of barrows from a platform above the machines, mentioned by Mr. Faulkner, was not novel, for it had been applied in this country with appreciable success. Also, the marking on the patterns of the positions of runners and risers had been applied here, and in one particular foundry that practice had been followed for 15 years with conspicuous success. It seemed to him to be the obvious thing to do where scientific control was aimed at, and where the foundry was expected to work under the best conditions.

Mr. M. J. Cooper asked what use was made of potassium bichromate, to which Mr. Makemson had referred in the course of his Paper.

AUTHOR'S REPLY.

Mr. Makemson, in his reply to the discussion and with reference to Mr. Faulkner's remarks on the lack of high-phosphorus iron in Czecho-Slovakia, pointed out that at the Vitkovice Works, iron with 1.8 phosphorus was made for basic steel making. The foundry pig-iron, however, produced by this company contained about 0.8 per cent. phosphorus. The reason why he had not made much reference to moulding-sand control was that the information which he had collected was not sufficiently definite to justify his putting it before them.

Labour Conditions.

Replying to the question by Mr. France with regard to labour conditions, he was informed that the wages paid at one works varied from about 6 to 12 Czech crowns per hr., the higher rates, of course, being paid to the skilled workers. As the present value of the crown is rather more than 2d., these wages were not dissimilar to those paid in this country, in fact, were perhaps rather higher. When the rates of exchange were normal, however, and the crown was worth about 1½d. in English money, the English equivalent in this money would be about 9d. to 1s. 6d. per hr. It was always difficult to obtain definite information regarding wages from a casual visit; one had to have access to figures. The hours of work were similar to our own. Many works started at 7.30 a.m., there was an interval of half an hour for lunch, and work ceased at an earlier hour than was the case in this country. The people of Czecho-Slovakia were very keen on sport, and the huge athletic organisation named "Sokol" had a membership all over the country. The closing of the works at a fairly early hour was of great assistance in this connection in the summer months.

The workmen appeared to be of a very good type, and on the whole were clean and neat in their personal appearance.

Runners and Risers.

It was pleasing to hear from Mr. France that the practice of standardising and specifying the position of runners and risers was followed in this country, but he asked if Mr. France was referring to iron or steel foundries in that connection.

Mr. France stated that he was referring particularly to brassfounding.

Mr. Makemson said that at the Skoda Works the practice was applied in the iron and in the steel foundries; it would be appreciated that it was probably of more importance in the steel foundry than any other department. Incidentally, he had noticed that the Skoda Steel Foundry seemed to encourage the use of a larger number of smaller risers instead of a few large ones.

(*Concluded on page* 314.)

Applications of Heat-Treated Cast Iron.

At a meeting of the American Society for Steel Treating, held at Detroit recently, Mr. Carl H. Morken presented a Paper on "The Heat-Treatment of Cast Iron," from which the following extract is taken.

Irons of high strength with good shock resistance, high endurance limit and high modulus of elasticity, states the author, are finding wide application. It is obvious that there is a wide breach between the properties of ordinary grey cast iron and those of steel. This breach is only partly filled by the conventional malleable iron. The engineer frequently specifies malleable because grey cast iron is too brittle or too low in strength for the job. He likewise frequently specifies steel castings or steel forgings because neither grey nor malleable castings are quite good enough. Nevertheless, he does not require the potential properties of steel.

Many of these parts are now being made from heat-treated cast iron with complete satisfaction. Such parts include underground cable brackets and clamps used in power-distribution systems, machinery cams, connecting rods, conveyor chains, dies, gear racks, gears, differential carriers and universal housings for automobiles, and many other similar products. In addition to possessing more than ample shock resistance and elastic limit, these irons are superior to steel in wearing qualities, stress-dampening properties, fatigue resistance and machinability.

One very interesting application of heat-treated iron is for street manhole covers. For this application a material of low yield point is not suitable, since it permits the cover to bend, after which it rattles in its frame as traffic passes over it. When made from grey cast iron the breakage was high, particularly in winter when, due to the snow melting off the covers, they are often several inches lower than the level of the surrounding snow and ice. When a heavy truck wheel drops from the snow to the cover the severe impact is frequently sufficient to cause failure. These grey-iron covers were heavy, weighing 212 lbs., and hard to handle. A heat-treated cast iron was designed for the job and the weight of the casting reduced to 172 lbs. This material has a high yield point (50,000 lbs. per sq. in.) and possesses good impact resistance.

Cast-Iron Camshafts.

Considerable development work has been done on heat-treated cast-iron camshafts and crankshafts for automobiles, Diesel engines, etc. Camshafts of this material are already in use in at least two automobiles, and it is probable that another automobile will be using heat-treated cast-iron crankshafts. The superior characteristics of this crankshaft as compared to the steel forging are: lower initial cost, lower machining and finishing cost, better wearing qualities, higher endurance ratio and better stress-dampening properties.

The field of heat-treated cast iron, both grey and white, has barely been opened. The future possibilities are tremendous, and because the electric melting furnace has provided the iron foundryman with a tool with which he can accurately produce and reproduce any predetermined composition of iron, the metallurgist has been able to establish his system of heat-treating the castings. One manufacturer of automatic parts is already producing heat-treated cast-iron parts, replacing malleable-iron castings, using a continuous furnace adapted from an idle carburising furnace. The cycle is less than 20 hrs.

A special cupolette has been installed at the Cardiff works of Messrs. John Williams & Sons (Cardiff), Limited, for manufacturing mixtures of cast iron having special heat-resisting and non-magnetic qualities. The company's galvanising plant has been increased.

Quenching of Steel Cylinders.

At a meeting of the American Society for Steel Treating held at Detroit recently, Mr. Howard Scott read a Paper on "Some Problems of Quenching Steel Cylinders." The following are the author's summary and conclusions.

The equations of transient heat flow in a long cylinder derived on the assumption that the temperature gradient at the surface is proportional to the surface temperature represent very well experimental cooling curves observed during quenching over moderate temperature ranges. The temperature ranges of correspondence are sufficiently long to permit important deductions regarding the effects of the major variables of quenching as it is usually practised.

Of the two constants required for solution of quenching problems, one, the diffusivity, is a characteristic of the steel, and the other, the quenching factor, is a characteristic of the bath for steels of the same thermal conductivity. Both constants were evaluated approximately for common steels and several quenching media. The diffusivity was estimated for steels in the austenitic condition because the cooling rate while the steel is in that state determines the end products of a quench.

The calculations necessary for the application of the equations of transient temperature change in a long cylinder were made and tabulated in a condensed form from which the effects of any one of nine factors concerned can be easily deduced. The variation of cooling rate at a significant temperature with several of the important variables was studied in detail and compared with experimental results so far as possible. These studies led to the following conclusions:—(1) Cooling-rate distribution can be determined by the method used under conditions not amenable to purely experimental attack. (2) The cooling rate at the centre of a long cylinder is indicative of the maximum size that can be fully hardened and can be estimated for water, oil or air quenching from its diameter with fair assurance. (3) The cooling rates at the centre of cylinders quenched in water or oil do not vary much from the maximum value over a considerable temperature range within which the rate of the Ar_1 reaction in the steel reaches a maximum. (4) During the quenching of larger cylinders in air or of very small ones in oil or water, the maximum cooling rate is reached shortly after beginning the quench and cooling thereafter is expressed by very simple relations. (5) As diameter is increased the advantage of water over oil quenching in producing faster cooling at the centre tends to diminish provided other factors do not change excessively. (6) A well-agitated water quench approaches close to the fastest physically attainable as judged by the cooling rate at the centre. (7) The chief advantage of exceptional quenching power is to ensure uniform shallow hardening in fine-grained steels.

High Chromium-Nickel Alloy.—In the course of an article in a recent issue of "Wire," Mr. John L. Everhart refers to an alloy having the following composition (per cent.):—Carbon 0.20 max., silicon 2.00 max., manganese 0.70 max., sulphur and phosphorus 0.03 max., chromium 23-27, nickel 17-21. It is expected that this alloy will be more suitable for certain articles which have previously been made in the well-known "18 and 8."

Cadmium-Nickel System.—A Paper presented to the American Institute of Mining and Metallurgical Engineers by C. E. Swartz and A. J. Phillips on "Notes on the Cadmium-Nickel System" concludes that a eutectic melting at 318 deg. C. has been found in the system cadmium-nickel. Its composition is 0.25 per cent. Ni, 99.75 per cent. Cd. Its components are cadmium and a cadmium-nickel compound. This compound is richer in cadmium than previously reported, and, if simple in composition, has a formula of $NiCd_4$.

Grey-Iron Castings for Laundry Machinery.

(*Concluded from page* 308.)

stated that he sometimes had a half-inch of clearance. He would like to know what Mr. Longden put in there. Mr. Longden had said that the pressure did not alter the thickness of the core; he would like to know what thickness of loam he had on to resist the pressure.

Mr. Longden said that perhaps Mr. Bruce might be right, and there might be a certain amount of thickening of the bottom of the core. He had, however, never noticed it. What they put on was white rope, and there had never been any difficulty. When the mould was cast, the bar began to expand. The thickness of loam along the main length of the core was 2½ in.

Mr. A. Bruce mentioned some cases where he had seen evidence of strain on the building plate. He said that in regard to the core which Mr. Longden had spoken about, he thought that if they had two courses of straw rope seven-eighths or three-quarters apart, there had got to be a very good layer of loam on that bar, and they would certainly get a strain. In his own case, they had to make castings as near as possible to the size ordered, and in many cases it would be impossible to do it on such a core. When they came to a cylinder of large diameter such as 36 in. and over there would be too big a strain.

Mr. Longden replied that he really could not say the cores did not yield at the bottom, but he had no reason to suspect that they did. The pressure on the castings was the same as on a heavier casting, but probably there was a good deal in what Mr. Bruce had said. When they had a building ring on a bricked-up casting the ring began to expand when the metal filled the mould more rapidly than the brick part, and perhaps there was some pushing out of the ring.

Czecho-Slovakian Foundry Practice.

(*Concluded from page* 313.)

Mr. Faulkner commented that in the aggregate they were heavier than they were in Great Britain.

Mr. Makemson said that he had noticed many heavy risers, but on the whole his impression was as stated.

Replying to Mr. Cooper's question as to the use of potassium bichromate, he said that at the Ceskomoravska-Kolben-Danek Works it was found that the magnesium-alloy castings were not particularly resistant to corrosion, but by dipping them in a solution of potassium bichromate their chromium resistance was increased. He gathered that the practice was followed in this country.

Finally, Mr. Makemson paid a tribute to the members of the Czecho-Slovakian Foundrymen's Association, to the courtesy with which they had received the visitors on the occasion of the International Conference, and for the great help they had given; he again referred particularly to Prof. Pisek, Mr. Kraus and Dr. Malkovsky.

At the conclusion of the discussion a vote of thanks was accorded Mr. Makemson for his Paper, on the motion of Mr. C. J. Burgess, seconded by Mr. M. J. Cooper, both of whom commented on his versatility.

Corrosion Measurements.—In a Paper in "Rev. Métallurg.," A. Portevin discusses the comparative accuracy of the various methods for estimating the loss of weight of metals due to corrosion, and gives the results obtained by the removal of corrosion products from steel using a Pomey solution. In a further Paper, the same author, in collaboration with E. Prétet and L. Guitton, describes experiments in which electrolytic iron and 13-per cent. Cr steel were dissolved in sulphuric and citric acids, which show that only a part of the hydrogen generated and as determined by the amount of metal dissolved can be collected in the free state. The possible means accounting for the loss of the absorbed hydrogen are discussed.

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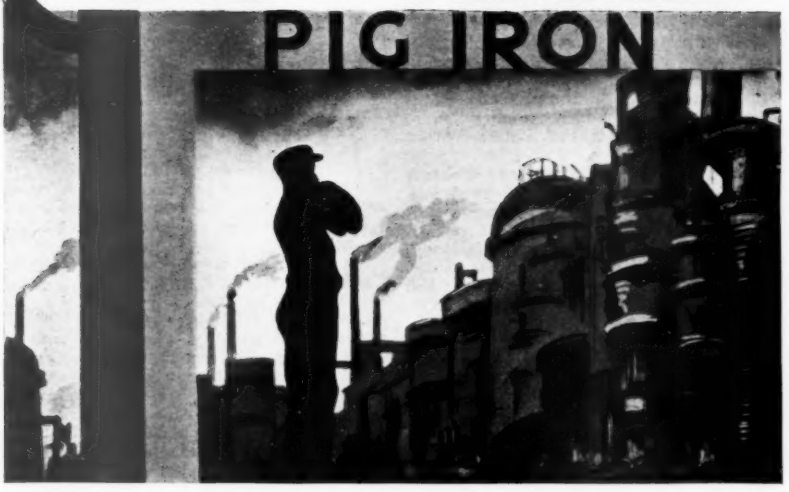

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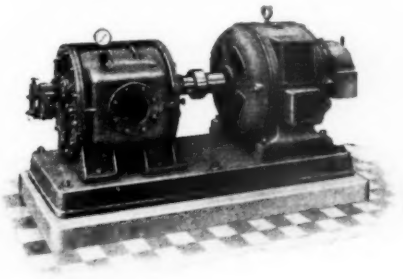

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This Week's News in Brief.

Trade Talk.

LIPTAK FURNACE ARCHES, LIMITED, have removed from 38, Victoria Street to 59, Palace Street, Victoria Street, Westminster, S.W.1.

PART OF THE Speedwell Iron Works, Coatbridge, has been bought for the manufacture of wire ropes. It is anticipated that employment will be provided for a large number of men.

MESSRS. GEORGE BROWN & COMPANY, LIMITED, Garvel Shipyard, Greenock, have secured the contract for the construction of two motor coasters, each of about 600 tons, for a British firm.

IT IS REPORTED that at Rotherham more goods traffic from the steelworks is now being handled than at any other time, including the war period. The tonnage is 25 to 30 per cent. greater than last year.

AN ORDER FOR 2,200 tons of steel, valued at £22,000, has been placed by the contractors for the new post office at Dunedin, New Zealand, with Messrs. Dorman, Long & Company, Limited, of Middlesbrough.

THE CAPITAL of Fry's Metal Foundries, Limited, has been increased by £20,000 to £150,000, for the purpose of acquiring the remaining issued preference shares of 10s. each (fully paid) in the Eyre Smelting Company, Limited.

THE FAIRFIELD SHIPBUILDING & ENGINEERING COMPANY, LIMITED, Glasgow, have secured one of the first contracts to be placed under the 1933 Admiralty programme. They are to build the coastal sloop "Kingfisher."

MESSRS. WILLIAM HAMILTON & COMPANY, LIMITED, Port Glasgow, have received an order from Messrs. T. & J. Brocklebank, Limited, Liverpool, for a cargo steamer. The vessel will have a length of over 450 ft. and a gross tonnage of 10,000.

BRYMBO STEEL WORKS, Wrexham, are to reopen. A number of men will be taken on immediately, and it is hoped to absorb all men who were employed at the works when they closed down three years ago. At one time 1,500 men were employed there.

AN ORDER for a large motor yacht has been placed with Messrs. James Adams & Sons, Limited, Gourock, by an English yachtsman. The vessel will be the largest ever built at Gourock, and will be fitted with Gleniffer engines to give a minimum speed of nine knots.

THE SUCCESS of the all-steel omnibus has created a new industry in Birmingham, and at the Saltley works of the Metropolitan-Cammell Carriage, Wagon & Finance Company, Limited, steel omnibuses are being made for many municipalities and transport firms throughout the country.

THE VULCAN FOUNDRY, LIMITED, Earlestown, Lancashire, has received a contract for 50 locomotives and tenders of a new design for the London Midland & Scottish Railway Company. Up to the present the Vulcan firm has been on short time with about 400 men. This order will mean employment for an additional 1,600 men. The work is expected to last nine months.

CONSIDERABLE EXCITEMENT and alarm was occasioned in the Phœnix Works of Messrs. Stewarts and Lloyds, Limited, at Rutherglen, near Glasgow, when it appeared that a storage tank containing hundreds of gallons of oil was in danger of catching alight. It appears that a spark from one of the furnaces, which are oil fired, ignited a wooden hut in the vicinity of the tank. The structure blazed up, but fortunately the fire brigade succeeded in extinguishing the flames before they reached the oil.

MOTHERWELL BRIDGE & ENGINEERING COMPANY, LIMITED, have secured several contracts which will keep the works fully employed for several months. The contracts include a combined road and rail bridge, consisting of two side spans of 128 ft. 10 in., and a centre span of 180 ft. 4 in., for the Crown Agents, Jamaica; a 75-ft. span road bridge for the Crown Agents, Kenya; and a road bridge over the Umhlatuzi River, Natal, consisting of two 200-ft. side spans and a centre span of 252 ft., for the public works department of South African Government.

AN IMPORTANT CONTRACT has been awarded to Stewarts and Lloyds, Limited, by the Crown Agents for the Colonies, for the steel portion of the pipe line required for supplying water to Jerusalem. The order consists of about 31 miles of 18-in. steel pipes, which are to be used for pumping water from the springs at Ras-el-Ain. There will be four pumping stations with a reservoir at each station. The mains will follow the railway to Ludd and thence the road from Jaffa to Jerusalem. The scheme is to be proceeded with immediately, and it is understood that the construction is in the hands of the Public Works Department, under the direction of Mr. Fawcett Pudsey, Director of Public Works, Palestine.

MESSRS. YARROW & COMPANY, LIMITED, announce that the Portuguese destroyer "Douro" was successfully launched at Lisbon by the President of Portugal. Sir Harold E. Yarrow, Bt., C.B.E., chairman and managing director of Yarrow & Company, Limited, was present. The "Douro" is the second of three destroyers being constructed in Lisbon under the supervision of Yarrow & Company. Two of the destroyers were completely built in Glasgow, the "Vouga" and the "Lima," and have been handed over after completing very successful trials on the Clyde. The third vessel is fitting out in Lisbon, and the fifth is well advanced. The whole machinery and boilers and all material for the three Lisbon vessels are being supplied complete from Messrs. Yarrows' works at Scotstoun, Glasgow.

IT IS ANNOUNCED that the L.M.S. Railway Company has placed an order with the North British Locomotive Company, Limited, Hyde Park Works, Springburn, Glasgow, for 50 large locomotives. Because of the dearth of orders, the company is at present working with a skeleton staff, but this contract will mean employment for a considerable number of men for a period of at least six months. It will also provide indirect employment to other workmen engaged in the heavy industries. The L.N.E.R. are also expected to place a large number of orders within the next few days, and it is anticipated that the North British Locomotive Company will get part of the work of building locomotives, and that Messrs. Hurst, Nelson & Company, Motherwell, will share in the contracts for the building of wagons.

Notes from I.B.F. Branches.

At a meeting of the Junior Section of the Lancashire Branch of the Institute of British Foundrymen, held in the Manchester College of Technology, on Saturday, November 25, Mr. F. Dunleavy, of Bolton, spoke on "Some Non-Ferrous Foundry Problems." Mr. R. A. Jones, of Pendleton, was in the chair. The lecturer illustrated his talk with several sketches, lantern slides and samples.

Among the many problems with which the lecturer dealt was that of "burning on," "on coating," of such items as shafts, etc. He stressed the need for a quick escape of mould gases, so that the shafts should not be overheated; the necessity of a good runner capable of flushing the mould immediately it was closed; and, again, when the mould is ready, the need for the shaft to be warmed up, wire brushed, put in the mould, the mould closed and cast.

The chairman complimented Mr. Dunleavy upon his lecture. Mr. Haigh proposed and Mr. Flower seconded the vote of thanks. The discussion was opened by Mr. A. Phillips, President of the Lancashire Branch, who also congratulated the lecturer upon his Paper.

A very animated discussion took place, in which many points were touched upon, including casting temperatures, compositions of different castings, Admiralty requirements, runner and riser problems and others.

Company Reports.

Dorman, Long & Company, Limited.—The directors have decided not to recommend the payment of any dividend on the 6 per cent. cumulative preference shares for the year ended September 30, 1933.

John Williams & Sons (Cardiff), Limited.—Profit, £6,468; brought in, £6,609; preference dividend, £1,500; dividend of 5 per cent. on the ordinary shares, £3,800; carried forward, £6,527.

Personal.

MR. ALEXANDER FERGUSON, who has been appointed fourth bailie in Prestwick Town Council, is a brassfounder, and carries on business in Glasgow.

MR. R. LINTOCK, of Motherwell, who has just retired after 54 years' service with the Excelsior Iron & Steel Company, Limited, Shieldmuir, Wishaw, is the sole survivor of the company's original employees.

MR. JAMES BRUNTON, a member of the Torwood Foundry, of Messrs. Jones & Campbell, Limited, Staffs, was recently presented with a writing bureau subscribed for by his fellow-workers and the management as a token of goodwill on the occasion of his marriage.

MR. G. H. NELSON, managing director of the English Electric Company, Limited, and MR. C. S. RICHARDS, joint managing director of the Metropolitan Vickers Electrical Company, Limited, have arrived in Warsaw to discuss work in connection with the electrification of Polish railway tracks.

AT A LARGE GATHERING of the employees of the Forth & Clyde & Sunnyside Iron Company, Limited, Mr. Cowie, on the occasion of his forthcoming marriage, was entertained and made the recipient of an easy-chair and ornamental table. Mr. T. Harrower presided and Mr. Johnstone, shop foreman, made the presentation.

MR. AND MRS. DONALD MCVEAN, of Linwood, Minard, Lochfyneside, have celebrated their golden wedding. Mr. McVean, who is a native of Kilmartin, Argyllshire, retired from Messrs. D. & W. Henderson & Company's employ five years ago after 38 years' service. He is a survivor of the "Daphne" disaster in July, 1883, which caused the loss of so many lives.

Wills.

MCGUIRE, FREDERICK GEORGE, of Glenbank (Co. Down), director of Messrs. Davidson & Company, Limited, Sirocco Works, Belfast £77,925

BARRACLOUGH, WILLIAM TETLEY, of Stanningley, near Leeds, managing director of William Barraclough, Limited, ironfounders £64,209

Obituary.

MR. WILLIAM HARRIDGE BURNS, who died last week at Bentham, Lancashire, at the age of 76, was for 30 years secretary of the Cleveland Institute of Engineers, a position which he relinquished a month ago.

MR. JAMES DICK, who has died at the age of 74, belonged to an old family of hand nailmakers who had lived in the St. Ninians district for over a century. For 29 years Mr. Dick lived in Falkirk, where he was in the employ of the Camelon Iron Company, but in 1914 he took over the family business of hand nailmaking.

MR. JAMES MACNAUGHTAN, who was formerly a partner in the Glasgow firm of Macnaughtan Bros., cast-iron-pipe founders and exporters, has died at Valencia, Spain. The firm had wide connections in Spain, and Mr. James Macnaughtan resided in that country for over 40 years. On the death of his brother, some years ago, the Glasgow business was discontinued.

THE DEATH OCCURRED, at his residence in Ayr, on November 23, of Mr. William H. Dalrymple, who until his retirement two or three years ago was manager of the Dalmellington Iron Company, Limited. A native of Gatehouse-of-Fleet, Kirkcudbrightshire, Mr. Dalrymple came to Glasgow in his early days and entered the employment of the Corporation. After a time he joined the staff of a city firm, and subsequently was appointed secretary of the British Hydraulic Foundry Company, Limited, Whiteinch, Glasgow, and ultimately became the commercial manager. He remained with the foundry company for many years until just after the war, when he was appointed general manager of the Dalmellington Iron Company, Limited. When the company was concerned in an amalgamation recently and became Bairds & Dalmellington, Limited, Mr. Dalrymple retired and went to reside in Ayr.

THE LONDON PASSENGER TRANSPORT BOARD has placed an order with Messrs. Dorman, Long & Company, Limited, Middlesbrough, for 4,340 tons of tram rails.

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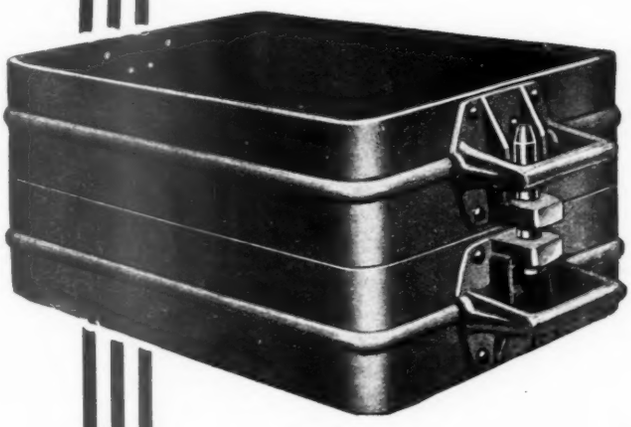

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BEDFORD

Raw Material Markets.

Active conditions continue to rule in the home iron and steel markets. The demand for pig-iron is, however, slightly less brisk, but this is due to the fact that so many consumers have already entered into contracts which will not expire for some months. The current output of iron is being well absorbed, and in some districts the furnaces are still having to make withdrawals from stock. Forward contracts are still being made, in some cases extending beyond next March. The steel market is steadily becoming firmer in tone.

Pig-Iron.

MIDDLESBROUGH.—The conclusion of a large number of forward contracts has caused slightly less active conditions to rule in the Cleveland iron market, which has now a very firm tone. The ironmasters are heavily booked over the first three months of 1934, and are chary of further committing themselves. The current requirements of local foundries continue to be fairly heavy, and good shipments are still being sent to Scotland, where Cleveland iron is preferred for a number of purposes, in spite of its being dearer than the corresponding Midland grades. The delivered prices of No. 3 Cleveland G.M.B. foundry iron to Scotland are :—Glasgow, 65s. 3d.; Falkirk, 62s. 3d.; whilst south of the Tweed the fixed quotations are :—Delivered Middlesbrough, 62s. 6d.; delivered North-East Coast, 64s. 6d. per ton. The premium for No. 1 foundry iron is still 2s. 6d. per ton, and a discount of 1s. is allowed on No. 4 foundry and No. 4 forge iron. For export, low figures have been quoted, without attracting much business.

The output of East Coast hematite is being fully absorbed, there being a heavy demand, not only from the local steelworks, but also from the Midlands, South Wales and Sheffield. Stocks are being steadily reduced. The quotation of 62s. 6d. for mixed numbers is being maintained, not only by the makers, but also by the merchants, and there is a possibility of a further advance.

LANCASHIRE.—Consumption of pig-iron is maintained at an improved level in this area, although activity is still rather restricted at the textile-machinery works, which form an important consuming industry in this area. It is thought that the November deliveries will turn out to have been the highest of the year. The gradual lessening of supplies of scrap iron in this area is also a point in favour of the pig-iron market. There has been no alteration in the price position of pig-iron, offers of Derbyshire, Staffordshire and North-East Coast brands of No. 3 for delivery to consumers in the Manchester zone being on the basis of 67s. per ton, with Northamptonshire at 65s. 6d., Derbyshire forge at 62s., Scottish foundry at around 80s., East Coast hematite at 76s. 6d., and West Coast hematite at 80s. 6d.

MIDLANDS.—The pig-iron market in this area remains firm, the majority of the furnaces being well contracted over the coming months, and unwilling to enter into further business of any size. The light-castings makers continue to account for heavy tonnages of metal, whilst conditions are reported to be picking up in connection with general engineering. Makers' stocks are still being drawn upon heavily, but there is no immediate danger of a shortage of No. 3 grade. As yet, there has been no alteration in the controlled prices of Midland brands of foundry iron. Northampton No. 3 is at 62s. 6d. per ton, and 66s. is the price for Derbyshire, Staffordshire and Lincolnshire No. 3, delivered Birmingham and Black Country stations, and subject to rebate to large consumers. No Continental foundry iron is coming through to this area, and only very small lots of Cleveland iron are used at the price of 72s. 6d. With the engineering trade slightly improved, there is more interest being shown in the better grades of iron. Medium-phosphorus iron is offered at 70s. to 80s. per ton, and low-phosphorus at anything from 80s. to 90s., according to analysis and source. For special work, such as cylinders, etc., where refined iron is used, the prices range from £5 15s. to £6 15s. per ton.

SCOTLAND.—It is reported that the general demand for pig-iron in Scotland fails to improve. Activity remains fairly high in the Falkirk district, however, and the founders there are all fully employed at the moment. There is no change in prices and No. 3 Scottish foundry iron is still at the official minimum of 65s. f.o.t. furnaces, with 2s. 6d. extra for No. 1. No. 3 Cleveland is at 62s. 3d. f.o.t. Falkirk, and the quotation for delivery in the Glasgow area is 65s. 3d. Falkirk founders are pressing for deliveries of both Cleveland and Northamptonshire iron, the quotations for the latter being 61s. at Falkirk and 64s. at Glasgow.

Coke.

No advance has yet been made in the price of foundry coke, although the general expectation of a rise has caused a considerable amount of forward buying during the past weeks. Quotations, therefore, remain as follow :—Best Durham coke, 36s. to 38s.; other grades, about 1s. less; Welsh coke, 31s. 6d. to 45s., according to quality; Scottish low-ash coke, 38s. 6d. to 39s.; delivered in the South Staffordshire area.

Steel.

Usually there is a tendency for business to decline a few weeks before the end of the year; but so far there has been no slackening in the active conditions which have ruled for some time in the British home market. The new railway and shipbuilding orders have improved the position and will supply work to departments which were not so well off for orders as the lighter branches of the industry. Although business in semi-finished steel material has been quiet, all the works engaged in producing this material are busily employed, and in many cases are behindhand in delivery. Continental competition, after being active for some weeks, has again become negligible, and the prices asked are only slightly below those of the British works. In the finished-steel department activity is increasing and seems to be spreading to branches which have hitherto not been affected by the general improvement. Export business also has been on a slightly larger scale.

Scrap.

The Cleveland scrap-iron market is a shade easier, following upon the recent heavy buying, and merchants are now showing more readiness to sell. Lighter metal is slightly weaker at 43s. per ton, heavy cast iron and machinery metal remaining at 47s. 6d. and 49s. per ton respectively. There continues to be a consistent demand for scrap from foundries in the Midlands, quotations in that area being 52s. 6d. for selected heavy machinery in handy sizes, 50s. for pipe and plate, and 42s. 6d. for clean light scrap, all delivered works. The demand is relatively weak in the Scottish and South Wales markets, where supplies are also plentiful.

Metals.

Copper.—The outlook in this market remains uncertain, but, temporarily, a slight improvement has set in. This is due to the small recovery in the dollar, coupled with an increase in European buying. Buying by consumers in this country has been rather on the weak side. The N.I.R.A. administration in the United States has not, as yet, settled upon the proposed "code" for the copper industry, the snag remaining the difficulty of reconciling the interests of the mining-smelting concerns and the custom plants.

The week's prices have been as follow :—

Cash.—Thursday, £29 6s. 3d. to £29 7s. 6d.; Friday, £29 6s. 3d. to £29 7s. 6d.; Monday, £29 15s. to £29 16s. 3d.; Tuesday, £30 2s. 6d. to £30 3s. 9d.; Wednesday, £29 11s. 3d. to £29 12s. 6d.

Three Months.—Thursday, £29 8s. 9d. to £29 10s.; Friday, £29 8s. 9d. to £29 10s.; Monday, £29 17s. 6d. to £29 18s. 9d.; Tuesday, £30 6s. 3d. to £30 7s. 6d.; Wednesday, £29 15s. to £29 16s. 3d.

Tin.—Demand on the part of consumers has slackened somewhat, business in this country and on the Continent being reported as only moderate, whilst on the whole quiet conditions have obtained in the United States of America. There is little material change to note in general conditions. The situation in America continues to be a dominating influence; the undertone nevertheless remains very firm, consumption still seems to be ahead of output, and a substantial decrease is expected in the total visible supply at the end of the month. The sharp fluctuations in the foreign exchanges and the uncertainties which still surround the industrial and economic position generally have a restricting influence on business, state Messrs. Rudolf Wolff in their weekly report. Were the situation in this respect to clear, prices would no doubt respond, for the future of this metal, in spite of the high price, is still regarded with moderate optimism.

Cash.—Thursday, £227 to £227 5s.; Friday, £226 to £226 5s.; Monday, £226 to £226 2s. 6d.; Tuesday, £225 12s. 6d. to £225 15s.; Wednesday, £225 10s. to £225 12s. 6d.

Three Months.—Thursday, £227 to £227 5s.; Friday, £226 to £226 5s.; Monday, £226 to £226 2s. 6d.; Tuesday, £225 12s. 6d. to £225 15s.; Wednesday, £225 12s. 6d. to £225 15s.

Spelter.—With the end of the month drawing near, dealing has been rather quiet on the London market. Consumers also have not been showing a great deal of interest in spelter. Prices have remained at a reasonable level, there being ample supplies available from Empire sources. Nothing seems to have been done as yet with regard to the further limitation of production. A cut was proposed in Cartel members' output quotas of from 50 per cent. to 45 per cent. of standard. A full meeting of the members is not likely until December 15.

Price fluctuations :—

Ordinary.—Thursday, £14 7s. 6d.; Friday, £14 10s.; Monday, £14 12s. 6d.; Tuesday, £14 17s. 6d.; Wednesday, £14 15s.

Lead.—The price of this metal has not fluctuated greatly during the past week. There has been a fairly good demand from consumers, but not sufficient to strengthen the market. Good supplies of this metal have been available, although shipments from Australia have been rather curtailed of late, owing to labour troubles at the mines.

Daily market prices :—

Soft Foreign (Prompt).—Thursday, £11 7s. 6d.; Friday, £11 10s.; Monday, £11 11s. 3d.; Tuesday, £11 11s. 3d.; Wednesday, £11 11s. 3d.

Continental Steel Cartel.

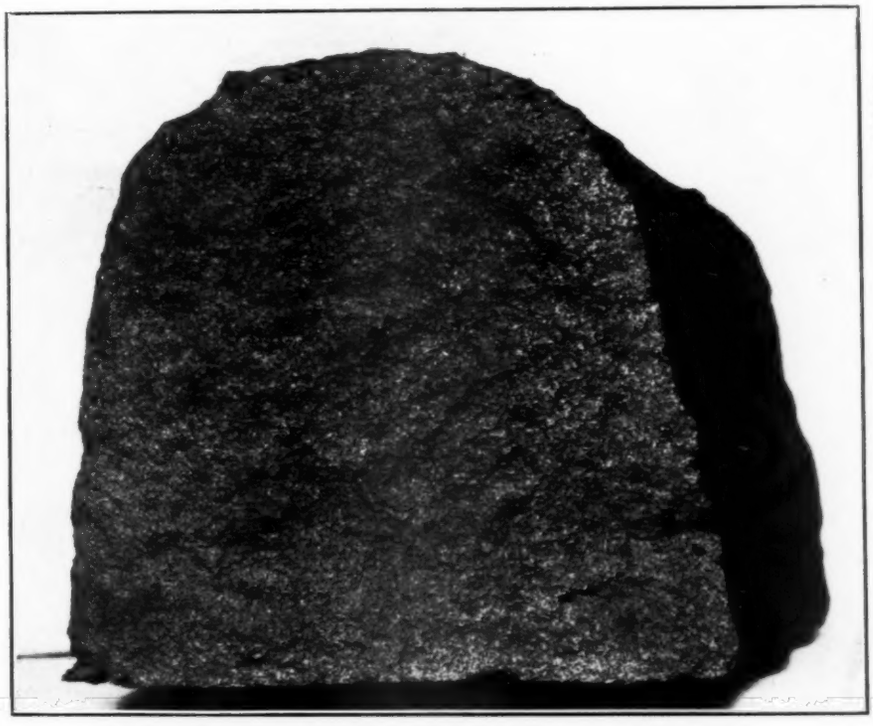
The committee of the Continental Steel Cartel dealing with the organisation of export markets met in Paris on November 17 and 18, when consideration was given to the trade conditions in Holland, Scandinavia, America and Portugal, and the business relations of export merchants with customers in these countries. A draft agreement regulating the activities of these merchants was prepared. No further change has been made in the basis prices of the international selling organisations.

Statistics have been published in Luxemburg of the steel production of the national groups in the Continental Steel Cartel covering the first nine months in this year. The figures are as follows (those for the corresponding period in 1932 being given in parentheses) :—Luxemburg, 1,425,600 (1,434,700) metric tons; Belgium, 2,067,000 (2,050,000) tons; Germany, 5,413,880 (4,182,905) tons; France, 5,013,000 (4,159,000) tons; Saar district, 1,241,000 (1,070,000) tons. The increase over the same period last year was 17.55 per cent., confirming the opinion that the worst of the crisis has been overcome. The total production of Cartel members is expected to exceed 20,000,000 tons this year, against 34,965,700 tons in 1929. The greatest improvement this year took place in Germany.

Statistical Year Book of the Iron and Steel Industry.—The north-western group of the Verein Deutscher Eisen- und Stahlindustrieller (Association of German Iron and Steel Industrialists) and the Stahlwerks-Verband A.-G. (Steelworks Association), Düsseldorf, have published the fifth edition of the "Statistisches Jahrbuch für die Eisen- und Stahlindustrie, 1933," which presents the usual exhaustive and valuable statistical survey of the world's iron and steel industries. Some slight change has been made in the arrangement of the countries, the first two sections being devoted to Germany and Austria, followed by other countries in alphabetical order. The principal additions are tables of the German exports of iron and steel manufactures and of Japanese exports. The new feature in the last issue, viz., tables of iron and steel supplies and consumption, is continued. The book may be obtained from Verlag Stahleisen m.b.H., Düsseldorf (price 5 Rmk.).

It's Results That Count

Frodair Brands



BEST AFTER TEST

FOR 50 YEARS

FRODAIR IRON & STEEL CO., LTD., FENCHURCH HOUSE, LONDON, E.C.3.

Telegrams: "Frodair, London."

RAW MATERIALS—PRICE LIST.

(Wednesday, November 29, 1933.)

COPPER.

	£ s. d.
Standard cash	29 11 3
Three months	29 15 0
Electrolytic	32 15 0
Tough	32 0 0
Best selected	32 10 0
Sheets	60 0 0
India	42 0 0
Wire bars	33 15 0
Ingot bars	33 15 0
H.C. wire rods	36 5 0
Off. av. cash, October	33 13 10 31/45
Do., 3 mths., October	33 17 2 11/16
Do., Sttlmnt., October	33 14 1 1/16
Do., Electro, October	37 7 0 9/16
Do., B.S., October	36 6 4 3/16
Do., wire bars, October	37 14 6 9/16
Solid drawn tubes	9¾d.
Brazed tubes	9¾d.
Wire	6½d.

BRASS.

Solid drawn tubes	8¾d.
Brazed tubes	10¾d.
Rods, drawn	8¼d.
Rods, extd. or rlld.	7¾d.
Sheets to 10 w.g.	7⅛d.
Wire	7⅜d.
Rolled metal	6⅞d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5⅜d.
Do. 4 × 3 Sheets	5¾d.

TIN.

	£ s. d.
Standard cash	225 10 0
Three months	225 12 6
English	226 5 0
Bars	227 15 0
Straits	229 2 6
Australian (nom.)	—
Eastern	231 0 0
Banca	228 12 6
Off. av. cash, October	223 10 7½
Do., 3 mths., October	223 8 11 1/32
Do., Sttlmt., October	223 10 10 10/11

SPELTER.

	£ s. d.
Ordinary	14 15 0
Remelted	14 15 0
Hard	12 15 0
Electro 99.9	17 2 6
English	15 12 6
India	14 15 0
Zinc dust	20 0 0
Zinc ashes	3 5 0
Off. aver., October	16 9 1 1/32
Aver. spot, October	16 6 2 7/32

LEAD.

	£ s. d.
Soft foreign ppt.	11 11 3
Empire	11 16 3
English	13 0 0
Off. average, October	11 19 0 1/4
Average spot, October	11 16 0 1/32

ALUMINIUM.

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	25 10 0
Do., V.M. ex whse.	23 10 0
Rods	28 10 0

ANTIMONY.

	£ s. d.
English	37 10 0 to 40 0 0
Chinese, ex-whse.	26 15 0
Crude	20 10 0

QUICKSILVER.

	£ s. d.
Quicksilver	9 10 0 to 10 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£6 10 0
45/50%	£12 10 0
75%	£18 2 6
Ferro-vanadium—	
35 50%	12/8 lb. Va.
Ferro-molybdenum— 70/75% carbon-free of Mo.	5/6 per lb.
Ferro-titanium— 23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten— 80/85%	2/6 lb.
Tungsten metal powder— 98/99%	2/9 lb.
Ferro-chrome— 2/4% car.	32 0 0
4/6% car.	23 0 0
6/8% car.	21 12 6
8/10% car.	21 12 6
Ferro-chrome— Max. 2% car.	34 10 0
Max. 1% car.	35 12 6
Max. 0.70% car.	37 10 0
70%, carbon-free	10½d. lb.
Nickel—99.5/100%	£225 to £230
"F" nickel shot	£202 10 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium— 96/98%	2/8 lb.
Ferro-manganese (net)— 76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese— 94/96% carbon-free	½ lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 5/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Heavy steel		2 10 0
Bundled steel and shrngs.	2 5 0	to 2 10 0
Mixed iron and steel	2 5 0	to 2 6 0
Heavy cast iron		2 5 0
Good machinery	2 7 6	to 2 8 6
Cleveland—		
Heavy steel		2 7 6
Steel turnings		1 11 6
Cast-iron borings		1 2 0
Heavy forge		2 10 0
W.I. piling scrap		2 5 0
Cast-iron scrap	2 7 6	to 2 9 0
Midlands—		
Light cast-iron scrap		2 2 6
Heavy wrought iron	2 10 0	to 2 15 0
Steel turnings, f.o.r.		1 8 6
Scotland—		
Heavy steel		2 7 6
Ordinary cast iron	2 7 6	to 2 8 0
Engineers' turnings		1 16 0
Cast-iron borings	1 15 0	to 1 17 6
Wrought-iron piling	2 10 0	to 2 11 3
Heavy machinery		2 11 3

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	24 0 0
Brass	17 10 0
Lead (less usual draft)	10 5 0
Tea lead	7 10 0
Zinc	10 0 0
New aluminium cuttings	73 0 0
Braziery copper	22 0 0
Gunmetal	23 0 0
Hollow pewter	145 0 0
Shaped black pewter	105 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees side area)—	
Foundry No. 1	65/-
Foundry No. 3	62/6
,, at Falkirk	62/3
,, at Glasgow	65/3
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	63/-
Hematite M/Nos., f.o.t.	62/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	69/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/-
,, No. 3 fdry.	66/-
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	62/-
,, fdry. No. 3	66/-
,, fdry. No. 1	69/-
Scotland—	
Foundry No. 1	67/6
,, No. 3	65/-
Hem. M/Nos. d/d	66/-
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	76/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	80/-
Clyde, No. 3	80/-
Monkland, No. 3	80/-
Summerlee, No. 3	80/-
Eglinton, No. 3	80/-
Gartsherrie, No. 3	80/-
Shotts, No. 3	80/-

FINISHED IRON AND STEEL.

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	9 0 0	to 9 15 0
Nut and bolt iron	6 17 6	to 7 10 0
Hoops	10 10 0	to 12 0 0
Marked bars (Staffs) f.o.t.		12 0 0
Gas strip	10 10 0	to 12 0 0
Bolts and nuts, ¾ in. × 4 in.		13 15 0
Steel—		
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.	8 5 0	to 8 10 0
Chequer plts.		10 7 6
Angles		8 7 6
Tees		9 7 6
Joists		8 15 0
Rounds and squares, 3 in. to 5½ in.		9 7 6
Rounds under 3 in. to ⅜ in. (Untested)		7 10 0 & up.
Flats—8 in. wide and over		8 12 6
,, under 8 in. and over 5 in.		8 17 6
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 0 0	to 12 5 0
Hoops (Staffs)	10 10 0	& up.
Black sheets, 24g. (4-t. lots)		10 5 0
Galv. cor. shts. (,,)		12 15 0
Galv. flat shts. (,,)		13 5 0
Galv. fencing wire, 8g. plain		14 0 0
Billets, soft	5 10 0	to 5 15 0
Billets, hard	6 17 6	to 7 2 6
Sheet bars	5 0 0	to 5 10 0
Tin bars		5 0 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10¾d.
Sheet to 10 w.g.	11¼d.
Wire	11¼d.
Rods	10¾d.
Tubes	14¼d.
Castings	12¾d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round— to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	18.26
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	13.50
Basic	18.89
Bessemer	19.76
Malleable	19.39
Grey forge	19.39
Ferro-mang. 80%, seaboard	82.00
O.-h. rails, h'y, at mill	36.37½
Billets	26.00
Sheet bars	26.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	1.74
Steel bars	1.75
Tank plates	1.70
Beams, etc.	1.70
Skelp, grooved steel	1.60
Steel hoops	1.85
Sheets, black, No. 24	2.25
Sheets, galv., No. 24	2.85
Wire nails	2.10
Plain wire	2.10
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.65

COKE (at ovens).

Welsh foundry	20/- to 25/-
,, furnace	17/- to 18/-
Durham foundry	21/- to 25/-
,, furnace	15/-
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	16/9 to 17/-
,,	28×20 ,,	33/6 to 34/-
,,	20×10 ,,	24/- to 24/3
,,	18⅞×14 ,,	17/6 to 17/9
C.W.	20×14 ,,	15/3 to 15/4½
,,	28×20 ,,	32/- to 32/3
,,	20×10 ,,	22/3 to 22/6
,,	18⅞×14 ,,	15/6 to 15/9

SWEDISH CHARCOAL IRON & STEEL.

	£ s. d.	£ s. d.
Pig-iron	£6 0 0	to £7 0 0
Bars-hammered, basis	£16 0 0	to £16 10 0
Bars and nail-rods, rolled, basis	£15 15 0	to £16 0 0
Blooms	£10 0 0	to £12 0 0
Keg steel	£30 0 0	to £31 0 0
Faggot steel	£18 0 0	to £23 0 0
Bars and rods dead soft, st'l	£10 0 0	to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

XUM

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Nov.	23 ..	29	6	3	dec.	1/3
,,	24 ..	29	6	3	No change	
,,	27 ..	29	15	0	inc.	8/9
,,	28 ..	30	2	6	,,	7/6
,,	29 ..	29	11	3	dec.	11/3

Electrolytic Copper.

		£	s.	d.		
Nov.	23 ..	32	15	0	inc.	5/-
,,	24 ..	32	15	0	No change	
,,	27 ..	33	0	0	inc.	5/-
,,	28 ..	33	10	0	,,	10/-
,,	29 ..	32	15	0	dec.	15/-

Standard Tin (cash).

		£	s.	d.		
Nov.	23 ..	227	0	0	dec.	7/6
,,	24 ..	226	0	0	,,	20/-
,,	27 ..	226	0	0	No change	
,,	28 ..	225	12	6	dec.	7/6
,,	29 ..	225	10	0	,,	2/6

Tin (English ingots).

		£	s.	d.		
Nov.	23 ..	227	10	0	dec.	10/-
,,	24 ..	226	15	0	,,	15/-
,,	27 ..	226	10	0	,,	5/-
,,	28 ..	226	5	0	,,	5/-
,,	29 ..	226	5	0	No change	

Spelter (ordinary).

		£	s.	d.		
Nov.	23 ..	14	7	6	dec.	1/3
,,	24 ..	14	10	0	inc.	2/6
,,	27 ..	14	12	6	,,	2/6
,,	28 ..	14	17	6	,,	5/-
,,	29 ..	14	15	0	dec.	2/6

Spelter (Electro, 99.9 per cent.).

		£	s.	d.		
Nov.	23 ..	16	15	0	dec.	5/-
,,	24 ..	16	15	0	No change	
,,	27 ..	16	17	6	inc.	2/6
,,	28 ..	17	2	6	,,	5/-
,,	29 ..	17	2	6	No change	

Zinc Sheets (English).

		£	s.	d.		
Nov.	23 ..	25	10	0	No change	
,,	24 ..	25	10	0	,,	,,
,,	27 ..	25	10	0	,,	,,
,,	28 ..	25	10	0	,,	,,
,,	29 ..	25	10	0	,,	,,

Lead (English).

		£	s.	d.		
Nov.	23 ..	12	15	0	No change	
,,	24 ..	12	15	0	,,	,,
,,	27 ..	13	0	0	inc.	5/-
,,	28 ..	13	0	0	No change	
,,	29 ..	13	0	0	,,	,,

AVERAGE MONTHLY PRICES OF STEEL RAILS.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1918	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6
1919	10 17 6	13 7 6	13 7 6	13 7 6	15 0 0	15 10 0	16 0 0	16 10 0	16 10 0	16 10 0	16 10 0	17 5 0	14 12 11
1920	18 15 0	19 5 0	20 7 6	22 0 0	23 0 0	23 0 0	24 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	22 18 11½
1921	23 5 0	20 4 0	18 0 0	17 0 0	15 0 0	15 0 0	14 0 0	14 0 0	14 0 0	11 12 6	10 10 0	10 0 0	15 4 3
1922	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 0 0	8 15 0	8 15 0	8 15 0	8 15 0	9 4 2
1923	8 17 6	9 2 0	10 5 0	10 10 0	10 10 0	10 10 0	9 15 0	9 0 0	8 15 0	8 15 0	8 19 0	9 5 0	9 9 10
1924	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 2 6	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 2 3½
1925	9 0 0	9 0 0	9 0 0	9 0 0	8 15 0	8 10 7½	8 10 0	8 10 0	8 10 0	8 4 0	8 0 0	8 0 0	8 11 7½
1926	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 10 0	8 3 11½
1927	8 10 0	8 10 0	8 10 0	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 3 0	8 5 0	8 5 0	8 4 10
1928	8 5 0	8 5 0	8 5 0	8 5 9	8 6 3	8 6 3	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 7 9½
1929	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1930	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1931	8 9 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 8
1932	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1933	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	—	—

AVERAGE MONTHLY PRICES OF EAST COAST HEMATITE AT MIDDLESBROUGH.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1917	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1918	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1919	122 6	122 6	122 6	122 6	179 2	190 0	197 6	200 0	200 0	200 0	200 0	200 0	171 4
1920	220 0	220 0	240 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	251 8
1921	240 0	220 0	180 0	180 0	180 0	160 0	160 0	160 0	137 0	127 6	117 6	104 6	162 2
1922	97 6	91 7½	100 0	98 6	97 1½	94 7	93 6	90 9	89 7	91 10½	93 0	93 2	94 5½
1923	94 6	104 9	122 0	126 10½	122 0	115 3	107 0	98 8½	98 10½	99 1½	100 6½	102 3	107 10½
1924	102 4½	101 3	99 7½	99 0	98 9½	97 4½	95 3½	93 1½	90 7½	88 0	88 4½	88 6	95 2½
1925	87 5	85 9	84 7½	82 6	80 10½	79 3	77 1½	75 7½	75 0	74 3½	74 9	76 0	79 5½
1926	77 3	77 9	77 3½	76 3	77 4½	78 0	79 8½	81 9	83 4½	87 7½	92 6	90 5½	81 7½
1927	90 0	90 0	86 3½	83 1½	80 6	78 0	76 6	75 4½	75 0	72 9	71 9	71 1½	79 2½
1928	69 7½	69 7½	69 9	70 0	70 0	69 3	68 7½	69 2	70 0	70 0	70 3	71 0	69 9½
1929	71 6	72 0	73 6	74 0	74 0	74 1½	74 9	75 6	76 1½	76 8½	78 1½	79 0	74 11½
1930	78 2½	78 0	76 9	75 0	74 0	72 7½	71 0	71 0	71 0	71 0	70 10½	70 4½	73 3½
1931	70 0	69 0	68 0	66 8½	65 1½	63 4½	62 9	61 1½	65 0	65 0	65 0	65 0	65 6
1932	64 10	64 3	63 6	63 6	63 6	62 7½	62 0	60 6	60 0	59 3	59 0	59 0	61 10
1933	59 0	59 0	59 0	59 0	59 0	59 0	59 0	59 0	59 3	60 7½	62 6	—	—

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